6GSNS

Annex to the SNS JU Work Programme 2025
SNS R&I Work Programme 2025

> **Note:** This Annex II is attached to the comprehensive Work Programme 2025 of the Smart Networks and Services Joint Undertaking (SNS JU). It details the planned SNS R&I Work Programme for year 2025. R&I WP 2025 will be published after approval of the SNS JU Governing Board.

Context and Objectives

The Smart Network and Services (SNS) JU is currently halfway through its full implementation. The Research and Innovation Work Programme 2025 (R&I WP 2025) will complete the second phase of the SNS JU and its follow up (2026) will kickstart the third phase. In this context, a number of recent and relevant developments has to be considered, notably:

Strategic Plan for Horizon Europe covering the 2025-2027 period

The new Horizon Europe (HE) Strategic Plan cover 3 Strategic Orientations (SO). They are taken into account in WP 2025 as follows:

a) **Green Transition:** this SO has been so far addressed as part of the sustainability objectives of the previous Work Programmes and this approach will be continued. Compared to the past, the notion of KVIs (Key Value Indicators) pioneered by SNS projects has now been widely recognised, including in non-R&D environments like the ITU (not yet included in the ITU-R Framework Recommendation). Still, significant work remains to qualify/quantify such indicators such that they can be used in a standardisation or certification context. WP 2025 and beyond hence includes efforts into a better qualification/quantification of the KVIs, leveraging the sustainability flagship project expected to start beginning of 2025, duly complemented with relevant R&I of WP 2025 and beyond. Main work focus should continue to address Sustainable Development Goals SDGs 8, 9, 11 and 13. For SDG 13 (Climate Action) directly relevant to the SO, work will cover both "Sustainable 6G" and "6G for sustainability".

b) **Digital Transition.** The outcome of the R&D activities on 6G is directly related to the Digital transition. The SNS R&I WP 2025 continues to offer key contributions in multiple domains: i) by fostering the emergence of advanced digital use-cases and business models in verticals sectors taking advantage of 6G intelligent connectivity; ii) by leveraging multiple digital domains and notably in semiconductors, photonics, digital infrastructure (high-performance computing, cloud-edge computing, communication networks), quantum technologies, cybersecurity, artificial intelligence (AI) as outlined in the Strategic Plan; iii) by further exploring the role of AI in network platforms, both as a tool to reach full network automation and as a service offered to network users and iv) by strengthening the services and sustainability orientations across service

provider administrative system domains to foster a stronger European provisioning ecosystem of interoperable cloud enabled smart networks and services

c) **A more resilient, competitive, inclusive, and democratic Europe**. This SO is addressed through the aspects of competitiveness and sovereignty. The former is a generic objective of the JU which targets a competitive EU supply side for 6G and Europe as a lead market for advanced multi-stakeholder platforms enabling interoperable smart network services. The latter is directly related to the work on security (e.g., Stream B), taking into account an end-to-end perspective where multiple business connectivity providers may operate, and to related cross cutting work aiming at leveraging 6G as a platform to develop an EU tech capability in sectors where the EU is less competitive, such as microelectronics and cloud computing.

Consolidation of a global 6G Vision

An important 6G related milestone was reached at the end of 2023, when ITU adopted its "IMT 2030 Framework document" [1] [2]. This document has now become a global reference for all R&I initiatives on 6G in the world and sets out a number of targets for research and innovation. Technical performance requirements will be provided by ITU-R beginning of 2026. It is expected that they cover enhancement of previous 5G performances and new capabilities, the resulting set of KPIs being considered in the Framework recommendation by a set of societal/sustainability design principles. Figure 1 indicates the main characteristics of the ITU framework and reflects how the 5G use cases are extended, what new use cases are considered and what horizontal non-functional properties are framing the development of 6G.
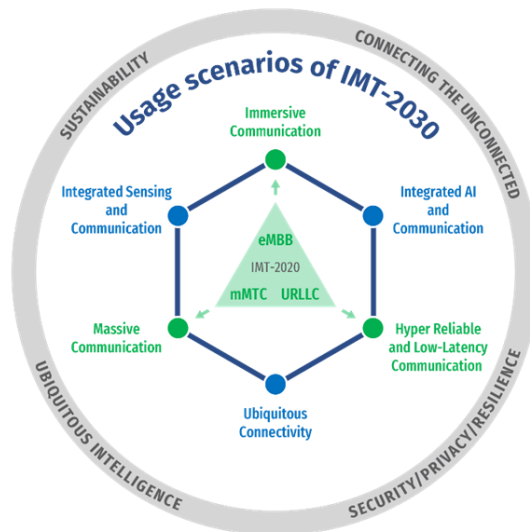

Figure 1: ITU framework & usage scenarios

This framework has largely been contributed by EU R&I and is hence in line with the SNS running R&I work. The WP 2025 therefore incorporates these targets whilst refining specific KPIs and investing efforts into the better qualification and quantification of KVIs to make them operationally actionable.

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[1] ITU-R: Future technology trends of terrestrial International Mobile Telecommunications systems towards 2030 and beyond. Report ITU-R M.2516-0, (11/2022), REPORT ITU-R M.2516-0 - Future technology trends of terrestrial International Mobile Telecommunications systems towards 2030 and beyond

[2] ITU-R: Framework and overall objectives of the future development of IMT for 2030 and beyond. Recommendation ITU-R M.2160-0 (11/2023), R-REC-M.2160-0-202311-I!!MSW-E.docx (live.com)

Progress of the 6G Landscape

Following the launch of SNS in 2021 and continuous SNS R&I progress over the last years, the overall technological landscape underpinning 6G is now better understood. This also applies for the business perspective, and the way 6G should be conceived as a follow up to 5G. The SNS programme takes on board resulting complementary approaches towards 6G:

- The need to support ever more powerful applications, notably in the VR/XR domains, which are pushing the limits of 5G technologies. Hexa-X-II has defined 6 classes of applications that frame the requirements towards much more advanced capabilities; the technologies to support these extended requirements have to be progressed, which forms part of the WP 2025 objectives.

- The need to rely on a successful 5G: SNS projects have also identified an evolutionary path towards 6G that largely leverages 5G investments whilst minimising the (costly) number of deployment options. This evolutionary approach and the associated technologies that will complement 5G are fully relevant in WP 2025.

- Taking into account the 5G experience, the take up of innovative services is necessary for the commercial success of a new technology. This requires leveraging 6G as an innovation service platform, starting from less complex services, but potentially enabling an evolutionary path towards 6G services. This evolution ability of 6G should also continue after 6G introduction to enable the support of new services during the whole 6G lifetime.

- Whilst an evolutionary perspective is gaining traction in Europe (e.g., NGMN White Papers[3]) other views (e.g. NextG Alliance Papers[4]) are also promoting more disruptive approaches, e.g. for what concerns future architectural approaches. Therefore, longer-term R&I is also covered in WP 2025.

Policy Objectives

On 21 February 2024, the European Commission adopted the White Paper "How to master Europe's digital infrastructure needs?"[5], which analyses the multiple challenges Europe faces in the rollout of future connectivity networks to meet the needs of the data-driven society and economy. It details a vision for the Connected Collaborative Computing Networks "3C Network. This vision calls for reinforced actions on the Telco Cloud in view of securing a better European position in the cloud and edge cloud domain, whilst progressing in other domains of the value chain like microelectronics.

The White Paper (Pillar 1) foresees the need to establish a coordinated approach to the development of integrated connectivity and computing infrastructures, making sure that today's connectivity providers become tomorrow's providers of collaborative connectivity and computing, capable of orchestrating the different computing elements that this ecosystem requires. To do so it is necessary to continue developing a synergetic ecosystem between actors.

Pillar 3 of the White Paper also outlines the need to ensure that such digital infrastructure is secure and resilient, as well as the complementary role of terrestrial and satellite connectivity solutions, for uninterrupted availability of service under all circumstances. Adequate attention

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[3] NGNM White Paper "6G Requirements and Design Considerations" (https://www.ngmn.org/publications/6g-requirements-and-design-considerations.html).

[4] Next G Alliance "North America 6G Roadmap Priorities" (https://nextgalliance.org/white_papers/north-american-6g-roadmap-priorities/?dl=19802008).

[5] COM(2024)81 White Paper – 'How to master Europe's digital infrastructure needs?' (europa.eu)

has to be given to physical security, notably in relation to the backbone infrastructure, as well as to the transmission of data from end to end of the network.

The White paper orientations have further received strong political backing through i) the Draghi report[6] recommending notably to "support research initiatives in the cloudification or virtualisation of communication platforms, customer-facing edge cloud solutions, and 6G development; ii) the objectives of the next Commission calling for a boost of secure high-speed broadband, both fixed and wireless[7]. These issues are further addressed in this Work Programme.

This WP 2025 considers the Telco Cloud from the perspective of an open environment, capable of supporting innovative services with capability exposures and leveraging already existing EU activities in the domain of open-source cloud technologies, including both services and infrastructure aspects. The activities are planned to be complementary to Horizon Europe Cluster 4 actions and will have a specific 6G focus with three key objectives: i) enable the distributed cloud implementation of an AI driven 6G like architecture; ii) enable test of key 6G innovations and functionalities and iii) enable the support of a secure/trusted service marketplace taking advantage of 6G capability exposures in several domains, including multi vertical APIs. This work will primarily address Pilar 1 (innovation) of the EC White Paper whilst the specific work on security and end-to-end secure infrastructures will be relevant to Pilar 3.

The work is also relevant in the context of several European policies[8], notably:

- Europe's Digital Decade, Path to the Digital Decade Policy Programme[9] and the Gigabit Infrastructure Act[10].

- EU Cybersecurity Act[11] (Resilient Communication Privacy via Developing Proper Security Strategies), Network and Information Security (NIS2) [12], EU Cyber Resilience Act[13] and the Commission Communication on the implementation of the 5G cybersecurity toolbox (C(2023) 4049 final) [14].

- Satellite communications Policy, e.g., Regulation establishing the Union Secure Connectivity Programme (IRIS2)[15][16].

- European Quantum Communication Infrastructure (EuroQCI) Initiative[17].

- European Chips Act[18] (Microelectronic components).

[6] EU competitiveness: Looking ahead - European Commission (europa.eu)

[7] Mission letters to the Commissioner Henna Virkkunen (EVP-designate for Tech Sovereignty, Security and Democracy): https://commission.europa.eu/document/3b537594-9264-4249-a912-5b102b7b49a3_en

[8] https://digital-strategy.ec.europa.eu/en/policies

[9] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en#the-path-to-the-digital-decade

[10] https://digital-strategy.ec.europa.eu/en/policies/eu-rules-reduce-cost-high-speed-broadband-deployment

[11] https://digital-strategy.ec.europa.eu/en/policies/cybersecurity-act

[12] https://digital-strategy.ec.europa.eu/en/policies/nis2-directive

[13] https://digital-strategy.ec.europa.eu/en/policies/cyber-resilience-act

[14] https://digital-strategy.ec.europa.eu/en/library/communication-commission-implementation-5g-cybersecurity-toolbox

[15] IRIS² | Secure Connectivity - European Commission (europa.eu) and Regulation - 2023/588 - EN - EUR-Lex (europa.eu)

[16] Mission letters to Commissioner Andrius Kubilius (Commissioner designate for Defence and Space) 1f8ec030-d018-41a2-9759-c694d4d56d6c_en (europa.eu)

[17] The European Quantum Communication Infrastructure (EuroQCI) Initiative | Shaping Europe's digital future (europa.eu)

[18] https://digital-strategy.ec.europa.eu/en/library/european-chips-act-communication-regulation-joint-undertaking-and-recommendation

- Artificial Intelligence (AI) [19], [20].

- Data, Cloud and Edge Computing[21], [22].

- High Performance Computing (HPC) [23].

- Internet of Things[24].

- Digitalising the Energy Systems Action Plan[25].

Protection of European Communication Networks as EU policy objective

The General Annexes of Horizon Europe's 2023-2025 work programme reiterate that the protection of European communication networks has been identified as an important security interest of the Union and its Member States[26]. Entities assessed as "high-risk suppliers" are currently set out in the second report on Member States' progress in implementing the EU toolbox on 5G cybersecurity of 2023 and the related Communication on the implementation of the 5G cybersecurity toolbox of 2023. In order to protect the specific policy interests of the Union and/or its Member States, the General Annexes state that it is therefore appropriate that additional eligibility criteria apply to actions identified as "subject to restrictions for the protection of European communication networks" that concern the evolution of European communication networks (5G, post-5G and other technologies linked to the evolution of European communication networks).

Developing Standardisation Plans

3GPP has by now defined its 6G standardisation roadmap, in parallel to the ITU work, and the 6G standardisation study work will start in 2025. The first 3GPP SA1 6G use-cases workshop was organized in May 2024. Considering the influence of the running SNS projects on the selection of the study items, the WP2025 focus is targeting to further test/validate early Standards and Systems and provide further input to future standardization phases/releases. A standardisation impact may be targeted on:

- The preparation of longer-term phases of 6G, for those network characteristics that will not be retained as priority Work items by 3GPP in the beginning (first release).

- The validation of KPIs and their technical low implementation cost, considering the ITU KPIs detailed definition expected in 2026.

- The progress on KVIs qualification/quantification.

- The implementation of the Work Items following the Study Items, as these should be developed in 2027, can also be considered.

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[19] https://digital-strategy.ec.europa.eu/en/policies/artificial-intelligence

[20] https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai

[21]https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en

[22] https://digital-strategy.ec.europa.eu/en/policies/cloud-alliance#:~:text=Cloud%20and%20edge%20technologies%20are,on%20cloud%20and%20edge%20technologies

[23] https://eurohpc-ju.europa.eu/index_en

[24] Europe's Internet of Things Policy | Shaping Europe's digital future (europa.eu)

[25] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022DC0552&qid=1666369684560

[26] https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2023-2024/wp-13-general-annexes_horizon-2023-2024_en.pdf

Sustainability

With the UN's Agenda 2030[27], a global framework for sustainability is available and Europe has acknowledged the importance of this ambition. The 17 SDGs have a very broad scope and paint the picture of a connected world where all parts matter. Applying them to the level of 6G development, there is consensus to equally address how the 6G end-to-end system will be sustainable ("Sustainable 6G") and how it will contribute to the sustainability of other sectors ("6G for Sustainability") through enabling use-cases with a positive footprint (also called enabling effect or handprint). This naturally encompasses all three pillars of sustainability (environmental, social, and economical), and specifically for network aspects of trustworthiness, privacy, and digital inclusion.

SNS technological roadmaps and Synergies

From October 2023 to April 2024, 6G-IA organized 6 workshops on the following topics: Microelectronics, Photonics, NTN, Security, Wireless and Cloud/Service Provision. The purpose of these workshops was to identify future strategic directions for the SNS JU for the years 2025 to 2027, starting with the NetworldEurope SRIA as the basis of 6G related technological topics. These reports have been approved by the 6G-IA Board and serve as input to relevant WP 2025 Streams and as a starting point for the WP 2026-27 discussions.

Regarding technological roadmaps and synergies, a summary of the results from the Workshops is as follows:

- **Microelectronics for Europe and Chips JU synergies**: The workshop has led to the definition of a Topic on "Front End Module" (FEM) that combines digital, RF, and packaging technologies to reach a reconfigurable, multi frequency, versatile front end for 6G, i.e. including prioritized spectrum, and capable of interference mitigations. It is proposed to run this Topic over the next Work Programmes, with WP 2025 being the first iteration, with a potential of transfer towards the Chips JU pilot line in due time.

- **Cloud computing technologies and 3C Networks**: The workshop has led to the definition of short and medium-term activities for both: a) cloud solutions and b) service provisioning. The key findings of the workshop include: a) that Europe should focus on open-source solutions to reach faster the target for European-wide accepted solutions, b) Target the standardization of the results so that future solutions will abide by the European rules for security, privacy, sustainability, etc., and c) Identify synergies among European funding instruments to maximize the impact of their activities and shorten the delivery of well-studied and tested solutions.

- **Photonics and Photonics PPP synergy**: The workshop has identified further R&I work on multiple aspects of photonic technology, covering especially architecture/protocols for space links, access or backhaul use cases, integration wireless and optical, optical sensing as support for services, quantum over fiber as main targets. These should be also developed in the context of sustainability (low-energy demand) and optical processing including AI capabilities.

- **NTN and Space component:** Lots of activities on 5G/6G are running through ESA, national Agencies and programmes, such as the Union Secure Connectivity Programme (IRIS2), which allows for the provision of commercial services by the European private sector. SNS is strong in facilitating bridges between the space and terrestrial community and current space contributions towards standardisation are planned through running SNS projects. In that context the workshop has identified a "TN-NTN" unification Topic, with WP 2025 being the first iteration. It targets reuse of

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[27] United Nations, Department of Economic and Social Affairs, Sustainable Development. (2020). The 17 Goals. https://sdgs.un.org/goals

similar protocols and technologies in both the TN and NTN segment where feasible, moving beyond the integration stage reached with 5G, and reusing test and demo capabilities of ESA, if appropriate.

- **Wireless**: The workshop has identified further R&I work on multiple aspects of wireless technologies (MIMO evolutions, physical layer technologies), on 6G RAN system aspects also covering topics in the upper midband spectrum (on top of below 6G, mmWave and THz), spectrum sharing/RAN co-existence, hardware development aspects and AI/ML and semantic communications related aspects.

- **Security** The workshop has identified further R&I work on multiple aspects of security-related technologies, such as SecOps, Secure AI, Physical layer security, secure service exposure, resilience and recovery, post quantum cryptography, DCS/CC, new paradigms e.g., deception MTD), evaluation certification metrics, CTI, supply chain/OSS/safe code etc.

The Move towards Openness

Openness of infrastructure is an important trend in the world, including in Europe. Beyond the proposed work on open-source infrastructures in the Telco cloud domain, several interfaces may need to become more open in future infrastructures[28]. On the other hand, industry needs to keep some specific implementation as discriminating factor of competitivity. Therefore, the WP 2025 has to look for the right balance where openness has clear advantages while not creating negative effects on both business and technology performance (e.g. on security, energy consumption etc.) and by targeting an innovation approach that allows service aggregation, monetisation and added-value creation from European actors. This is particularly relevant for the test and demo platforms targeted under Stream C.

International Cooperation

International cooperation in this work programme targets early visibility of global 6G activities, the preparation of international consensus on technologies and systems in the standardisation context, the facilitation of the emergence of global ecosystems, the alignment of global developments on key horizontal issues like sustainability and security, the understanding of the European positioning on global value chains and of optimised supply chains.

Taking into account the policy developments between EU and US on 6G under the EU-US Trade and Technology Council (TTC) promoting cooperation on 6G between R&I funding agencies and the links established by 6G-IA with the US NextG Alliance, EU-US cooperation may be materialized under Stream B, if applicants consider this as relevant.

More specifically, in these Streams and for projects which include US subsidiaries, it is expected to establish cooperation and provide wide visibility of the related undertaken R&I, notably how the work relates to the related US developments under the Next G Alliance and the related US R&I funding programmes, how it represents EU-US collaboration opportunities and how it paves the way towards complementary advanced research and supply chains for 6G. These EU-US cooperation activities will be consolidated at programme level considering input from relevant projects. It is noted that the inclusion of US subsidiaries in project consortia is not mandatory and will not influence the evaluation results whatsoever.

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[28] See Open Network White Paper of 6G-IA [6g-ia-open-sns_open-networks-status-and-future-development_ran-final.pdf].

Work Programme 2025 framework

Within the above context, the SNS R&I WP 2025 further advances the technological and business realisation of the 6G vision, targeting massive digitisation of societal and business processes through intelligent connectivity across the human, physical and digital worlds[29]. The 6G R&I focus of the SNS R&I WP 2025 covers enabling technologies with dedicated prototyping and experimentation, towards (sub)system R&I, whilst also considering longer-term disruptive technologies.

The proposed work addresses notably:

- Moving beyond a simple increase in speed or performance of connectivity platforms, and beyond 5G capabilities, bringing unique new service capabilities with wider economic implications. It requires capabilities for new classes of services and applications as defined e.g. in Hexa-X II, aligned with sustainability targets and a human-centric approach. This will eventually lead to 6G services, like the "Internet of Senses", realizing a fusion between the communication and sensing environment, massively scalable immersive environments, like XR/VR, digital twins, and holographic type communication.

- The integration of future connectivity and service platforms into larger globally applicable infrastructures, including their fully automated (AI support) management whilst preserving European competitiveness and sovereignty. The implementation of networks increasingly takes place across heterogeneous domains and with open technologies (e.g. open-source solutions for telco cloud), and the challenge is to keep a strong EU influence whilst ensuring service delivery and control from an E2E perspective.

- Extended European effort across the value chain, from microelectronics to service platforms.

- Trust, security and communication privacy-enhancing technologies, processes and architectures as required for massively heterogeneous, virtualised and software platforms of the future, as well as the associated enablers for such developments.

- Participation of new actors from and beyond the verticals. Contributions from industry, Research Technology Organisations (RTOs), Universities and Small and Medium-sized Enterprises (SMEs) actors in the connectivity, IoT and cloud/IT domains are expected to be complemented by appropriate participation of the microelectronics and photonics industries, in view of their potential impacts in the standardisation process.

- A stable experimental framework towards minimising R&I risk and validating core technologies and use-cases.

- A unified consensus framework promoting a European approach towards 6G that takes into consideration national specificities (e.g. current infrastructures, economic power, societal needs), facilitating international cooperation and placing Europe on par with other regions developing bold 6G initiatives. From an industrial perspective there should ideally be no standardised variants of 6G to achieve economy of scale and affordable cost.

- Leveraging standardisation stages, including a consensus of 6G KPIs and KVIs [30] that will frame future developments. The consensus on KPIs for research and innovation is outlined in key documents like the ITU Recommendation "Framework and overall objectives of the future development of IMT for 2030 and beyond" and the final KPIs in the Technical Performance Requirements Recommendation (expected beginning of 2026). Therefore, the SNS R&I WP 2025 focuses on (1) the validation of the KPIs

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[29] https://5g-ppp.eu/wp-content/uploads/2021/06/WhitePaper-6G-Europe.pdf
[30] https://hexa-x.eu/wp-content/uploads/2023/07/Hexa-X-D1.4-Final.pdf

where a consensus has been established (2) the further definition of the specific European KPIs that are not yet reflected in international consensus (3) progress on the KVI's definition towards their operational usage.

- The integration of concepts and technologies originating from the Cloud/IT/Microelectronics environments to support massive device (IoT) connectivity and ultra-reliable communications and services on top of enhanced mobile broadband services. The target is to address a comprehensive value/supply chain materialised by an IoT device-connectivity-service platform.

- The stimulation of strategic alliances, with vertical (industrial) sectors to build and offer powerful and persuasive Business to Business (B2B) and Business to Consumer (B2C) propositions. This should leverage upon general, local, regional, or even global smart interconnected public and private networks and services. A strategic goal of the SNS JU is to empower many vertical domains with capabilities beyond what is currently possible with 5G networks. Participation and contribution of these actors to the SNS R&I WP are considered important, both to drive the requirements and to validate the technologies and their versatility in specific business contexts.

SNS R&I WP 2025 further addresses medium and higher TRLs[31], complementing SNS R&I WP 2024. It also includes a specific focus on low TRL in Stream B targeting future 6G developments and disruptive technologies for 6G.

Work Programme 2025 Structure

Against the above background, the scope of the SNS R&I WP 2025 considers the full value chain. It is based on the NetworldEurope Strategic Research and Innovation Agenda (SRIA) duly completed by a series of thematic workshops and fuelled by specific policy requirements.

The SNS R&I WP 2025 includes the following three complementary streams: [32]

- **Stream B:** it covers research for revolutionary and evolutionary technology advancements, in preparation for 6G and revolutionary and evolutionary advancements including IoT, devices and software. This Stream targets both low-medium TRLs leveraging WP 2024 with the objective of delivering innovative solutions towards real-life networks in a short to medium-term period and also low TRL targeting forthcoming 6G / disruptive technologies in a long-term period. The Stream contains the Topics dedicated to wireless communication and signal processing, communication infrastructure technologies and devices, and reliable services and smart security. A dedicated Topic on the design, development and testing of a Front-End Module (FEM) is also included.

- **Stream C:** it focuses on SNS Enablers and Proof of Concepts (PoCs) used to further develop and consolidate experimental infrastructure(s), in support of the various phases of the SNS JU. Stream C developments in WP 2025 has a particular focus on 6G Telco Cloud and service platform, using Open-Source technologies and addressing longer term parts of the 3C Networks orientations.

- **Stream D:** it targets SNS Trials and Pilots with Verticals, including the required infrastructure. The aim is to explore and demonstrate technologies and advanced applications and services for the vertical domains. SNS R&I WP 2025 Stream D projects are expected to mostly rely on SNS Phase 1, and early Phase 2 (Call 2023

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[31] Technology Readiness Level – wp-13-general-annexes_horizon-2023-2024_en.pdf (europa.eu)
[32] Stream A of the Phase 1 SNS WP (2021-2022) is not supported in SNS Phase 2 WPs (2023, 2024, 2025), being too late to further influence 5G Advanced standardisation.

and Call 2024) technologies and especially the infrastructures being developed from Stream C projects. The Stream D projects are also expected to use results from other HE calls (e.g., Cluster 4) or results on 6G from national initiatives. The goal is to further incorporate innovative 6G functionalities.

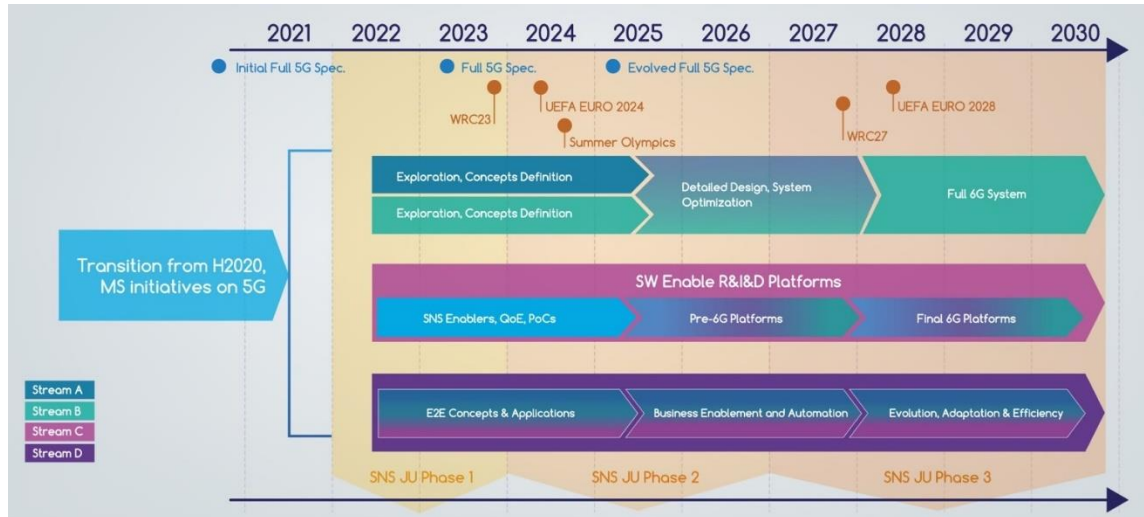The updated SNS roadmap (Figure 2) illustrates the phases of the Streams.

Figure 2: SNS Roadmap

Figure 3 presents how the outcome of each Stream is combined with other Streams activities and results during the following SNS Phases. Thus, it is envisioned that complementary results from the Streams may be re-used in subsequent Phases.

The arrows in Figure 3 illustrate how the outcomes of projects in Phase 1 will be used in Phase 2, and then could be used from Phase 2 to Phase 3. More specifically,

- Stream C Experimental Infrastructure technologies are expected to serve as the basis for subsequent phase Stream D Vertical Pilot projects.

- 6G solutions and potential PoCs, developed in Stream A (only in WP2021-22) and B are expected to contribute to the Experimental Infrastructure projects (Stream C) and Vertical Pilot projects (Stream D) of subsequent SNS JU phases.

- Experimental Infrastructure projects (Stream C) and especially Vertical Pilot projects (Stream D) are expected to provide new requirements (e.g., KVIs, KPIs) to Stream B projects of latest SNS JU Work Programmes. The further development of Stream C projects is expected to follow a spiral evolutional approach, subject to the successful delivery of selected projects.

- The further development of Stream D projects is expected to follow a spiral evolutional approach, subject to the successful delivery of selected projects.
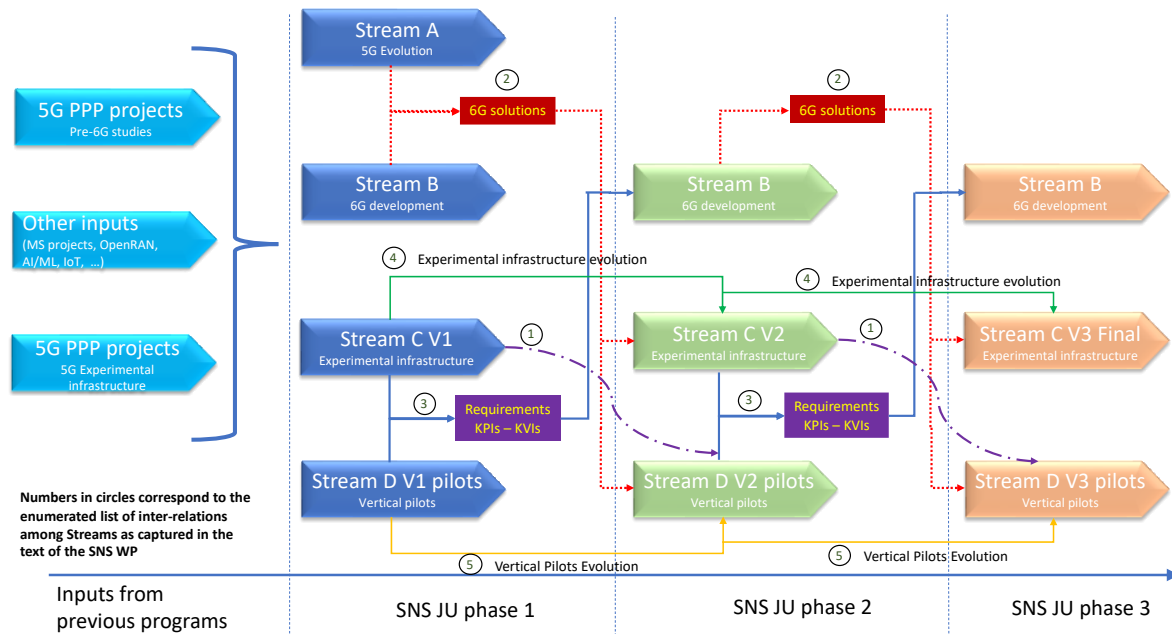
Figure 3: Interlinking of Streams into Phases

The R&I work of the Streams is expected to validate feasibility of a well-defined set of 6G KPIs emerging from the international agreements on 6G KPIs as available at the time of the start of the new projects, possibly complemented with ad-hoc KPIs not reflected in international settings like ITU, e.g., considered in the NetworldEurope SRIA KPIs, 6G KPIs produced by other projects, etc. In addition, definition and validation of KVIs will show how the SNS projects contribute to societal impact, to vertical sector applications and to the European industrial competitiveness. Applicants are invited to get familiar with the European background work on KPIs and KVIs[33].

Multiple initiatives have already been launched and progressed in several Member States (MSs) and Associated Countries; These are expected to develop related operational and important results. Where applicable, applicants are encouraged to use results from such initiatives, to maximise the efficiency of public investments in Europe, which allow for synergies among different funding instruments and thus, create positive multiplier effects. Several actions are developed in SNS context to develop synergies with MSs 6G Programmes (see e.g. SNS SRG activities, SNS ICE CSA project and 6G-IA signed MoUs).

It is also important to note that retained projects of the various Streams will have to cooperate in the SNS Programme for issues of common interests with arrangements set out in the written Collaboration Agreement in order to ensure a programmatic approach and achieve the SNS JU objectives.

Inter-Projects Cooperation towards KPI/KVI definition and measurement

In the context of the assessment of telecom networks, systems and components, there is a need to clearly define, for each relevant (technical) KPI, the appropriate measurement methodology, baseline and scenarios, in order to allow for meaningful, commonly agreed and accepted indicators (e.g., upload/download data rates; latency; energy efficiency). Taking into account the importance of KPIs and KVIs, projects are expected to collaborate in relevant collaborative structures such as in relevant Working Groups (WGs) and Task Forces to come up with unified definition of KPIs and KVIs and the way to measure them.

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[33] https://www.sciencedirect.com/science/article/pii/S0308596124000752

HORIZON-JU-SNS- Stream B - Research for revolutionary and evolutionary 6G Technology and systems

Specific Challenges and Objectives

The Stream targets both (1) a higher TRL range compared to the SNS JU Calls 2022 and 2023 and similar to the SNS Call 2024, aiming to bring more mature results, including PoCs, and to create a significant impact on standardisation activities and in addition (2) low TRL to prepare 6G / disruptive technologies around and beyond 2030.

This Stream addresses the industrial, societal and technological long-term challenges related to the global introduction of 6G systems by 2030 including:

- **Reinforced European leadership in 6G technologies:** Smart Networks and Services including connectivity extended to devices, enabling technologies and service infrastructures, underpinning the emerging 6G vision of intelligent inter-connectivity between the physical, digital, and human worlds, supporting massive digitisation of our economies and societies.

- **Further integration with verticals** and fine-tuning of network functionalities and interfaces to support specialized services.

- **Disruptive high-value applications** support, with performance requirements beyond those of current 5G capabilities (scalability and new KPIs and KVIs), especially for highly immersive and "digital twinning" applications.

- **Green transition** contribution with significantly lower energy and natural resources (raw materials, water, land) needs for high-rate/performance connectivity and capabilities to decrease energy needs and footprint of use cases.

- **SDGs** support and in particular connectivity and service availability (inclusive coverage), affordability (cost) and (safe) accessibility and resilience for a large and diverse number of people towards use cases demonstrating a range of societal, economic, and environmental goals of high public value (SDGs 8, 9, 11 and 13).

- **Innovative business models** based on managed end-to-end service provision over heterogenous business and technological domains.

- **Global single standards** for 6G, enabling interoperability, economies of scale and of scope.

- **Mobilisation of the core EU networking and service industries**, in partnership with relevant academic, RTO and user actors, in view of downstream impact at standardisation level.

The Stream also addresses an integrated ecosystem with IoT, devices hardware and software-based solutions. The comprehensive system target is based on a globally connected continuum platform with the convergence of networks and IT systems supporting future digital services.

The following specific objectives are relevant for this Stream:

- Availability of key technologies and open architectures with high potential for 6G standardisation and smooth migration from 5G.

- Further evolution of the 6G architecture investigating key topics from short-range communications up to non-terrestrial networks (NTN), for public and private networks, focusing on native AI solutions, advanced data transport schemes, defining new northbound interfaces, for a more efficient services-to-networks interoperation, as well as interfaces for inter-operator federation, digital twinning and integrated and dependable sensing and actuation networks.

- Energy-efficient solutions from an architectural, hardware and software implementation perspective considering various aspects from optical networks to the interoperation of IoT devices with the network elements, short range networks.

- Higher speed optical access networks and future end-to-end packet optical network architecture for 6G by considering contributions from adaptive multiband optical transmission, optical sensing for environment and networks including integration of photonics and wireless sensing, open and disaggregated optical networks, AI enabled optical network automation and AI enhanced green optical networks and system.

- Developing leading 6G radio access network solutions capable of meeting the strictest 6G KPIs and KVIs, considering advances on cell free and extreme MIMO, joint communication and sensing, key functionalities in RAN (e.g., modulation, coding, synchronisation, multiple access etc.), machine learning physical layer evolutions, and seamless integration of multiple frequency bands.

- Validating bands with mobile allocation for potential 6G usage and advanced technologies for workable sharing scenarios where appropriate.

- Energy-efficient device, network, and service infrastructures, to deliver critical services in a sustainable manner. It also includes enablers and open APIs to improve the operation of verticals and significantly reduce footprint of use cases (e.g. energy, carbon, environmental) making use of the 6G connectivity platform (e.g., automotive, factories, healthcare, etc.). An upgradable and modular architecture and system design is envisioned to support sustainability in an evolutionary approach.

- E2E secured, trustworthy, resilient and reliable solutions that will also fulfil the requirements stemming from EU policies,

- Multi-layer Federated Cybersecurity Solutions including Security for terrestrial and non-terrestrial networks, federated/hybrid classical/emerging security solutions, multi-layer cybersecurity protection and threat and risk assessment.

- Dynamic end-to-end distributed security for connectivity, devices and service infrastructures extending the current set of patchy technologies for service security, trust and resilience towards a comprehensive end-to-end framework across heterogeneous environments. This security "lifecycle" should be provisioned to account for distributed systems (e.g., asset orchestration and data aggregation), operational security, security quantification, and a strategy for ongoing security threat assessment.

- Fostering European capabilities in key technologies and notably AI/ML, software and security enablers, and advanced signal processing, paving the way towards advanced fully automated systems across all network layers.

Note 1: Cloud and edge-cloud technologies and software implementation of network/device are expected to be addressed with a clear strategy for EU supply capabilities and opportunities, including for security solutions, in the context of a future cloud continuum that may involve interoperation with non-EU systems, such as the hyperscalers. Their relation to the 3C Network strategy should be highlighted, especially for what concerns synergy/complementarity with already running initiatives, including CIS-IPCEI.

Note 2: Sustainability is an important element of WP 2025 for all Stream B projects, so any results should also identify any impact/contribution they may have on sustainability and propose tangible progress on KVI qualification/quantification.

Note 3: Stream B activities are expected to demonstrate strong capabilities towards valorisation of results in relevant 6G standardisation context and explain how this will be reached.

Note 4: Where relevant, specific solutions and results from other R&I sources (e.g., other European and national projects) could be considered for inclusion to relevant Stream B activities.

Note 5: Considering the start of 3GPP standardization activities in 2025, no dedicated 6G Architecture projects (former Topic B01-01 in previous SNS R&I WPs) are targeted in WP 2025. Architecture R&I is though in scope in the context of Disruptive Technologies for 6G Topic (low TRL projects). Streams C and D may also be used to demonstrate/validate earlier work on Architecture.

HORIZON-JU-SNS-2025-STREAM-B-01: Disruptive Technologies for 6G

Over the last decades, communication networks have integrated a multiplicity of technologies in view of serving an ever-larger set of applications and performance requirements. The integration of new technologies with communication platforms has two basic motivations: i) to perform similar functionalities as previous generations but with better performance and/or non-functional properties; ii) to enable new use case scenarios that previous generations could not allow. This integration of innovative technologies over time is well reflected in the evolution of previous generations of mobile networks, that span in average a time window of about 10 years between the very first release of a new generation and the most sophisticated release of that generation.

In the above context, the objective of Topic B-01 is to explore promising technologies that are at a very early exploratory stage of research, still with some prospect to become part of new advanced systems (potentially 6G technologies beyond 2030). The proposed work hence targets long-term R&I starting at low TRL (starting at TRL 1-3 and not above) with projects expected to prepare the forthcoming definition of technologies and concepts for advanced 6G. The projects inside B-01 must not reassess technologies, which currently are at higher TRL level in the state-of-the-art, covered under different Topics on this Call.

The topics under this Topic are broadly defined, such that innovative R&I organisations can adapt the work to their potentially disruptive implementation ideas within the proposed scope, retaining flexibility to extend from it, within the theme and the topics outlined in the SNS and NetworldEurope SRIAs.

SNS-2025-STREAM-B-01-01: Advanced Architectures Systems and Technologies

Call: HORIZON-JU-SNS-2025 (see Appendix 1)	
Specific conditions	
Expected EU contribution per project	The SNS JU estimates that an EU contribution of around EUR 3 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 15 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	Specific eligibility conditions apply and are described in Horizon Europe WP2023-25 General Annexes. Exceptions apply as detailed in the SNS R&I WP2025 Appendix 1 – Section 2.B (pending final decision).

Technology Readiness Level	Activities are expected to start at TRL 1-3 and to reach TRL 3-4 by the end of the project. The projects must not reassess technologies, which currently are at higher TRL level in the state-of-the-art, covered under different Topics on this Call.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The expected outcomes are addressing several technologies and architectures that have the potential to simplify the operations of a network, decrease operational expenditures, or allow for new service or service models to be deployed. They target mainly:

- The definition and design of innovative more efficient and simplified advanced 6G architectures (Control and/or User plane) enabling a seamless grow of service deployments without constraints, targeting long-term evolution of 6G architectures.

- The definition and performance characterisation of novel techniques for constrained AI operations, notably from an energy perspective, from real-time learning perspective and for optimal deployment of computation resources.

- Identification and performance characterisation of technologies and architectures for provision/orchestration of a multiplicity of telco or verticals backend services through serverless computing across multiple domains and for vertical use cases.

- Entirely new optically based, ultra-high speed, low-latency network architectures with fast optical switching and real-time control to replace electronic switching, routing and memory, within IP routers, and reduce overall power consumption by an order of magnitude.

Scope

Proposals should address one of the following five areas (and clearly identify which area is being addressed):

1) New architectural solutions: New architectural solutions targeting the simplification of the architecture (user and control plane) enabling operators to introduce and operate services more efficiently, effortlessly integrate and connect new network domains (considering that any device can operate as a network node), as well as enable users to seamlessly roam across operators, and network technologies and domains. It covers current limitation of the Service-Based Architecture (SBA), legacy constraints and evolution from early 6G architectures (e.g. Hexa-X II model).

2) Deep learning models: The development and evaluation of deep learning models that include predefined constraints either from a network operation viewpoint or from a user service provision viewpoint. The constraints may be in the form of physical law, logical rule, or any other domain specific knowledge, with an end-to-end connectivity perspective. Of particular interest are problems related to AI optimization under energy and/or under security constraints. The scope covers constrained deep learning by incorporating constraints into the learning process for network processes optimisation, as well as interconnection of untrusted data sources.

3) Real time serverless computing: The scope covers provisioning and orchestration algorithms and technologies for database and storage services towards the widespread implementation of "Function-as-a-Service" (FaaS). It allows execution of

code on various parts of the network (e.g. edge) and support the versatile/optimised function placement and dynamic replacement expected in 6G. Also in scope is research on methods for instant start (to overcome the cold start characteristics of the scheme), high-dimensional task orchestration across multiple stakeholders, and imposing embedded security in such infrastructures.

4) Autonomous Cognitive Agents: The definition of architectures with a focus on simplicity, scalability, and security with a focus on the holistic combination of service composition and knowledge handling in a network-compute continuum where the network and applications merge in an organic way and operations are carried out in a decentralized manner. These Multi-agent systems, possibly but not necessarily based on LLMs, should be able to excel the performance of individual agents. The agents can potentially invoke each other spontaneously and can be operated in a decentralized manner, thus departing from the relatively static architectures we know today, but will need to remain under effective control of adequate service management models.

5) Goal-oriented Communication: The definition and design of revolutionized effective goal-oriented communication protocols, languages, and media among devices and machines equipped with AI, especially those with generative AI technologies, allowing them to extract and communicate only goal-relevant information, possibly directly in various waveform formats, to reduce communication, computing, storage, and energy consumptions. Full system concepts are expected, including the ancillary control and management aspects imposed by these technologies.

Note: To ensure a balanced portfolio within this cluster of activities focusing on Advanced Architectures Systems and Technologies, grants will be awarded to proposals not only in order of ranking but at least also to one project that is the highest ranked within each of the above 5 areas/priorities, provided that the proposals attain all thresholds (and subject to available budget). Proposals may want to address several of the proposed priorities, but they should indicate clearly what is the centre of gravity of their proposal (i.e. the main covered priority). See General call conditions, section 2.F of Appendix 1.

SNS-2025-STREAM-B-01-02: Advanced IoT and Device Technologies

Call: HORIZON-JU-SNS-2025 (see Appendix 1)	
Specific conditions	
Expected EU contribution per project	The SNS JU estimates that an EU contribution of around EUR 3 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 9 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	Specific eligibility conditions apply and are described in Horizon Europe WP2023-25 General Annexes. Exceptions apply as detailed in the SNS R&I WP2025 Appendix 1 – Section 2.B (pending final decision).

Technology Readiness Level	Activities are expected to start at TRL 1-3 and to reach TRL 3-4 by the end of the project. The projects must not reassess technologies, which currently are at higher TRL level in the state-of-the-art, covered under different Topics on this Call.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The expected outcomes are addressing several technologies and architectures that may be applicable for a wide range of innovative IoT connectivity scenarios as those described by the Use Case analysis of the Hexa-X-II flagship project. They target mainly:

- Characterisation and performance studies of technologies enabling the advent of (close to) zero-energy devices, in particular for unattended long-term IoT operations with minimal loss of performance from the network side.

- Enabling technologies and architectures to operate 6G for IoT in unlicensed bands (6G-U) in promising related use-case scenarios (e.g., industrial deployment).

- Design of novel innovative IoT connected devices and operation modes that will enable new services and applications supporting IoT scenarios in a 6G context and showing clear performance improvements (KPI and/or KVI) over a legacy 5G implementation.

Scope

Proposals should address one of the following three areas (and clearly identify which area is being addressed):

1. Sensing and connectivity technologies and architectures to enable the advent of (closed to) zero energy devices: The technologies enabling the device to function without being battery powered are in scope as well as the networking protocols and the optimised connectivity operation enabling the overall energy budget to remain close to zero, in demanding IoT scenarios (e.g., for long-term unattended operations such as for the whole device lifecycle). This may also include passive and battery-less NTN IoT terminals and components allowing ultra-low power/unattended operation.

2. Communication technologies and architectures enabling 6G unlicensed operations for IoT: Related use-cases environments of interest are e.g. industrial environments, healthcare/hospital deployment, campus networks. Aspects of (fast) deployment in these contexts should be considered as well as the related data processing over a computing continuum that may span multiple domains and service requirements.

3. IoT applications that can benefit from 6G characteristics, offering better performance compared to a 5G implementation: The scope includes both the optimization through 6G features of applications of diverse nature, with technologies enabling a wide range of versatility and intelligence for implementation/deployment of the needed service features required to serve the target use cases as well as the design of novel connected IoT devices that will enable new services and applications.

Note: To ensure a balanced portfolio within this cluster of activities focusing on IoT devices and technologies, grants will be awarded to proposals not only in order of ranking but at least also to one project that is the highest ranked within each of the above 3 areas/priorities, provided that the proposals attain all thresholds (and subject to available budget). Proposals may want to address several of the proposed priorities, but they should indicate clearly what

is the centre of gravity of their proposal (i.e. the main covered priority). See General call conditions, section 2.F of Appendix 1.

HORIZON-JU-SNS-2025-STREAM-B-02: Wireless Communication Technologies and Signal Processing – Standardisation and Follow-up/PoCs

Specific Challenges and Objectives

The usage scenarios of IMT-2030 are envisaged to be either (i) built on top of those defined in IMT-2020 (i.e. eMBB, URLLC, and mMTC) evolving into the so-called immersive communications, hyper-reliable and low-latency communication, and massive communications usage scenarios featuring more stringent and simultaneous KPIs and KVIs; or (ii) feature new ones such as ubiquitous connectivity able to enhance connectivity through interworking with other systems; artificial Intelligence and communication, or integrated sensing and communication. As in the case of previous generations, the 6G radio access network, and the wireless communications and signal processing technologies are called to play a pivotal role in meeting the stringent requirements associated to i) those highly complex 6G usage scenarios/use cases, ii) technology trends and iii) the foreseen standardization roadmap. The RAN WG in Rel-20 of 3GPP will cover the 6G study item from Q3/2025 until Q4/2027. The IMT-2030 submission and normative work for 6G in 3GPP are expected to start from Rel-21. Given this timeline, a prompt engagement of the key industry players and related stakeholders in RAN development is needed at this stage. It is also estimated that roughly 75% of the energy consumption in 5G networks takes place in radio access networks, while the network core, owned data centres and other operations account for the rest. This calls for a careful analysis of the environmental sustainability aspects of the 6G RAN.

Call: HORIZON-JU-SNS-2025 (see Appendix 1)	
Specific conditions	
Expected EU contribution per project	The SNS JU estimates that an EU contribution of around EUR 7 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 21 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	Specific eligibility conditions apply and are described in Horizon Europe WP2023-25 General Annexes. Exceptions apply as detailed in the SNS R&I WP2025 Appendix 1 – Section 2.B (pending final decision).
Technology Readiness Level	Activities are expected to start at TRL 2-3 and to reach TRL 4 by the end of the project, and if/where relevant up to maximum TRL 5 (mature 6G technologies and solutions for verticals). Some parts of the project may only target TRL 3 by the end of the project.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

- Optimized physical layer solutions and methods for an efficient, affordable, and accessible use of frequency spectrum, able to meet 6G technical KPIs and KVIs.

- Development of algorithms for massive MIMO systems for increased channel capacity and coverage improvements under difficult propagation conditions.

- An AI-native framework for RAN networks based on AI/ML and semantic technologies.

- Technologies and approaches for co-existence/sharing with other communication systems.

- Mechanisms and strategies to underpin automation and disaggregation in the RAN segment.

- Integration of function accelerators at the 6G RAN/compute continuum, where required.

- Algorithms, software and hardware implementations that can be eventually used for PoC and trials systems.

- Contributions to international standardisation.

Sustainability (from environmental, economic and societal perspectives) might be regarded as a horizontal aspect to be addressed by the aforementioned priorities, wherever possible. Developing technologies that will maximize system and equipment lifetime, thanks to modular, evolutive and flexible design that unlock the ability to adapt to new services, support new capabilities and satisfy 6G performance requirements is a relevant outcome.

Scope

The scope of this topic focuses on the following areas:

- Physical layer technologies for enhanced spectral efficiency which includes energy-efficient new waveform design (featuring e.g., low PAPR, low complexity processing), backwards compatibility with existing CP-OFDM waveforms, or self-synchronizing modulation and waveform. Modulation and coding aspects are also in scope, including source-channel codes for short packet transmission, coding and caching for over-the-air computing in the network edge, or energy-efficient implementation of key physical-layer algorithms such as FEC or channel estimation. Asynchronous non-orthogonal multiple access schemes (e.g., NOMA, RSMA), advanced interference cancellation, advanced (full) duplexing strategies, or UE relaying can be considered, as well. Where relevant, RAN coordination (e.g., multi-TRP), improved lower layer signalling in 6G Air Interface, or physical-layer security aspects can also be addressed.

- Extreme exploitation of MIMO technologies, this including advanced massive MIMO technologies and extremely large antenna arrays (XL-MIMO) for increased network capacity and spectral efficiency and/or enhanced indoor coverage/localization; holographic beamforming and novel beam management schemes in massive MIMO settings leveraging on hybrid analog-digital front-end architectures; scalable, robust and low-complexity/overhead CSI acquisition strategies; massively distributed and cell-free MIMO technologies and architectures for improved coverage, reliability and mobility support and related synchronization, calibration and coordination aspects.

- AI/ML & semantic communications targeted at providing a native AI framework for RAN networks by using AI/ML for the lower layers of the protocol stack (e.g., including PHY, MAC and resource optimization), including AI-assisted multi-user and massive-MIMO systems channel coding aspects, the reduction of power consumption in the RAN or multi-modal model training (e.g., vision-assisted) for improved radio/network efficiency. Protocol learning, automated generation of lean, customizable neural radio protocol stacks, and learning networks, as well as related aspects such as distributed and centralized learning trade-offs, or conflict and anomaly detection and resolution are also in scope. This focus area notably includes semantic communications, or

trustworthy/safe/explainable AI and the exploitation of generative AI for RAN optimization.

- Spectrum sharing and RAN co-existence focuses on aspects such as dynamic spectrum sharing between 5G and 6G, spectrum sharing and coexistence mechanisms to enable 6G in 7-15 GHz band, spectrum sharing and re-use for sustainability; overcoming limitations of variable numerology and, where deemed relevant, spectrum sharing with satellite, radar, or other terrestrial networks.

- Automation and disaggregation in the RAN segment: leveraging on open RAN architectures this area includes AI/ML powered automation and optimisation, micro-orchestration of RAN functions, programmable networks and API native, and exposure of network capabilities.

- Agile use of function accelerators at the 6G RAN/compute continuum which includes the integration of multi-processor SoC/accelerators, flexible and modular hardware/software architectures for communication-compute-control co-design, heterogeneous resource management, while meeting the new requirements and expectations on confidential computing solutions.

Note: Applicants may address a subset of the above priorities/areas. To facilitate the evaluation applicants should clearly identify the areas they are comprehensively addressing.

HORIZON-JU-SNS-2025-STREAM-B-03: Communication Infrastructure Technologies and Devices – Standardisation and Follow-up/PoCs

This Topic is composed of two core domains: Non-Terrestrial Networks (NTN) and Photonics. For the NTN part, the approach is to consider a "unification/integration Topic" and for Photonics to integrate higher speed optical access networks into the 6G architecture and to further develop the future end-to-end packet optical network architecture. These activities are expected to span over the next work programmes in view of generating critical mass.

Specific Challenges and Objectives

a) Non-Terrestrial Networks (NTN) are becoming an integral part of future Mobile networks. The satellite communication domain has significantly changed over the last decade. The tremendous progress of the domain has allowed to radically bring down the cost of spacecrafts and of launches down to a level where constellations with hundreds or thousands of satellites may be commercially conceived. Low Earth Orbit (LEO) systems, in particular, are conceptually not new, but the current prospects offered by performance advances and lower costs could make possible the provision of space-based communication services whose characteristics (throughput) are complementing terrestrial systems, notably by providing specific characteristics such as wide area coverage and an access cost independent from the population density. Today, multiple satellite constellations are being considered by industry or already launched and considered as tools of sovereignty and resilience by governments across the world. These radical evolutions have led the satcom stakeholders to consider more systematically the maximum possible integration with 3GPP based terrestrial networks to provide an access/networking continuum, where resources are seamlessly managed for Terrestrial or Non-Terrestrial systems. This approach gives access to the 3GPP ecosystem of standardised technologies, which has proven its power to drive down costs through economies of scale, provide global solutions and global interoperability. It also contributes to accessing to the user terminals market base, the corresponding retail channels, and applications with their associated ecosystems. Against this background, the specific challenge and objective of the proposed activity is to move towards a unification of terrestrial and space-based systems for the provision of advanced mobile services, with a level of integration going one step further compared to the integration of systems reached

at 3GPP with a set of specification enabling interworking and integration between the two segments. The challenge of unification rests with the reuse, insofar as possible, of the same (potentially tuned) technologies, architectures, protocols and interfaces for both the satellite and terrestrial segments, without the need of dedicated technological developments for the NTN part. The proposed activity is part of a Topic that potentially spans several Work Programmes to mobilise critical mass and efforts in the domain, with WP 2025 focusing on unification of technologies, protocols and architectures in complement to what ESA/Space Agencies are supporting, also taking into account the demanding requirements of the most innovative use cases of NTN, such as Direct to Device (higher rate than state of the art) or PPDR. The intention is to address additional technologies in subsequent Work Programmes whilst moving toward demonstration of critical technologies. From an SNS perspective and taking into account the significant investments of the Union as well as of national Space Agencies in the field, the key added value is to maximise seamless collaboration between the NTN and TN communities and to leverage collaborative advantage for the associated ecosystems.

b) Photonics and especially optical networks play an increasing role for the overall 6G Architecture in the different domains from the home and business premises in the subscriber domain to the access and optical domain for metro and regional networks. Long-haul networks including sub-sea optical links connect continents The optical network can be extended by optical Non-Terrestrial Networks and free space or optical wireless systems. Communication networks are transformed to full fiber and later to new fiber networks. Today, GPON (Gigabit Passive Optical Networks) are further developed to XGS-PON (10 Gbps) and, HS-PON (50 Gbps) systems. HS-PON (100 to 200 Gbps) is studied as next generation with an expected deployment after 2032 and longer-term research is ongoing towards Tbps PON systems. In addition, topologies which are today common in metro networks, like dense division multiplexing (DWDM) rings or horseshoes might expand their domain to centralized RAN deployment to provide features like link protection and dynamic traffic allocation enabled by tuneable optical interfaces. Original networks based on dedicated hardware and proprietary management systems are transformed into software defined access networks using disaggregated hardware platforms. Research and development is targeting autonomous and intelligent networks.

While future packet-optical networks need to be updated in order to support all upcoming applications and services, they will in particular support the transformation of 6G radio networks. Enhanced photonics enable transport networks, including fronthaul and backhaul, to support higher throughput rates and thereby higher network capacities. In addition, features such as fast switching, reconfigurability and automation are becoming possible. The energy-efficiency of the network fabric between mobile base stations / access points, switches/routers and data centres is much higher from the use of optical technologies and wideband optical interconnects. Photonics also help mobile and wireless systems to increase bandwidth and throughput, where the power consumption is growing less than proportional compared to the increase in throughput. In this sense optical networks contribute to improved sustainability of communication infrastructure.

Optical components are developed in other initiatives, mainly in Photonics 21 PPP and Chips JU, while SNS activities are targeting the networking aspects and the integration of photonics systems and optical networks into the 6G architecture. The WP 2025 is focussing on these aspects with respect to sustainable and high-performance systems.

HORIZON-JU-SNS-2025-STREAM-B-03-01: 6G NTN-TN Unification/Integration

Call: HORIZON-JU-SNS-2025 (see Appendix 1)
Specific conditions

Expected EU contribution per project	The SNS JU estimates that an EU contribution of around EUR 8 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8 million.
Type of Action	Research and Innovation Action
Eligibility conditions	Specific eligibility conditions apply and are described in Horizon Europe WP2023-25 General Annexes. Exceptions apply as detailed in the SNS R&I WP2025 Appendix 1 – Section 2.B (pending final decision).
Technology Readiness Level	Activities are expected to start at TRL 2-3 and to reach TRL 4 by the end of the project, and if/where relevant up to maximum TRL 5 (mature 6G technologies and solutions for verticals). Some parts of the project may only target TRL 3 by the end of the project.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The main outcome will be the availability of core technologies, architectures and protocols that can be indistinctly used for terrestrial or non-terrestrial networks for the provision of seamless services across an access and network fabric continuum overcoming the distinction between satellite and terrestrial access with seamless roaming capabilities between the two segments (beyond Hybrid network). It targets:

- Architectures and technologies requiring a very tight cooperation between the SNO and the MNO's, towards a seamless TN-NTN communication continuum, and catering for a multiplicity of possible business models across the various domains.

- End to end service capabilities either through a TN segment or through an NTN segment, depending on relevant parameters including coverage, RT or NRT constraints, bandwidth and sustainability aspects.

- Innovative models such as managed multi tenancy of the space segment.

- Independent reconfiguration of the NTN part for performance, security and resilience optimisation.

- Compatibility with the most innovative use cases and their demanding requirements such as high rate Direct to Device, PPDR and other NTN specific use cases.

- Adaptability of the technologies, protocols and architecture (or a subset of those) to non-satellite scenarios such as drones or other flying 3D nodes.

The proposed Topic should cover R&I issues for low and medium TRL topics and plan, towards the end of the SNS implementation (i.e. later work programmes), for demonstration of critical technologies and applicability to specific use cases, e.g. with ESA partnership or national initiatives where possible, possibly using low-cost demonstrators such as Cubesat or equivalent EU offers.

Scope

The scope of this topic focuses on the following areas:

- Management of multiple access networks through unified Control Plane capable of optimizing TN-NTN service provision according to traffic related parameters (QoS level, bandwidth, sustainability, latency, storage requirements...) and related RAN management, also accounting for very demanding use-case scenarios including public safety use-cases (e.g. PPDR) and system relying exclusively on satcom connectivity like aeronautic use cases.

- Management capabilities for independent reconfiguration of the NTN part for performance, security and resilience optimisation at system and subsystem level.

- Dynamic routing in multi-dimensional networks with selection of optimal paths for traffic, which is a key feature in leveraging the potential of NTN-TN unification and integration including optical links, improving (transport and mobility) protocols, flexible topology and traffic routing across such dynamic topologies with long-propagation link characteristics. For what concerns optical links (ISL) the approach is to consider them at system level characteristics and performance properties. However, development of specific technologies/subsystems for ISL is not in scope.

- Extension of a reference multi orbit constellation system(s) as evaluation framework for the assessment of routing and mobility schemes including various architectural splits. It should cover robustness of the scheme for disaster situation when TN is not available. The reference system may also address feasibility of the constellation considering spectrum usage from existing systems.

- Spectrum issues including i) novel schemes for dynamic spectrum access and sharing in FR3 (7 – 15 GHz possibly extended up to 24 GHz), providing good cost-coverage trade-off; ii) where applicable dynamic reuse of TN frequencies for NTN use where TN spectrum is not assigned or for very demanding scenarios including public safety use-cases.

- Multi tenancy and end to end resource slicing capabilities across multiple tenants, covering the space resources and including seamless mobility and handover between various segment, either TN to NTN or across 2 NTN infrastructures.

- Adaptability and versatility of the scheme to cover also non satellite 3D connected nodes and early system concepts (to be developed in subsequent phases) to provide GNSS free positioning with a better positioning accuracy/availability.

Notes: i) Specific satellite technologies such as advanced payloads and multi satellite generated antenna are not in scope from an in-depth R&I perspective. Their characteristics may be considered at system level where appropriate, but their detailed development is not part of the SNS JU WP objectives, ii) satellite architectures with different levels of data processing (e.g. transparent or regenerative space segments) are in scope.

Applicants should clearly identify the areas/priorities they address in case they only cover a subset.

HORIZON-JU-SNS-2025-STREAM-B-03-02: Higher Speed Optical Access Networks and future end-to-end Packet Optical Network Architecture in 6G

Call: HORIZON-JU-SNS-2025 (see Appendix 1)
Specific conditions

Expected EU contribution per project	The SNS JU estimates that an EU contribution of around EUR 8 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8 million.
Type of Action	Research and Innovation Action
Eligibility conditions	Specific eligibility conditions apply and are described in Horizon Europe WP2023-25 General Annexes. Exceptions apply as detailed in the SNS R&I WP2025 Appendix 1 – Section 2.B (pending final decision).
Technology Readiness Level	Activities are expected to start at TRL 2-3 and to reach TRL 4 by the end of the project, and if/where relevant up to maximum TRL 5 (mature 6G technologies and solutions for verticals). Some parts of the project may only target TRL 3 by the end of the project.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The main outcome will be the availability of higher speed optical access networks and future end-to-end packet optical network architecture to be integrated and interfaced to the overall 6G architecture. Such systems can be applied to all domains in the system and allow a very energy-efficient data transport for very high throughput rates. Main targets are:

- Integration of high performance and highly efficient passive optical network based on various technologies (e.g., PON or DWDM) and adaptive multiband optical transmission, including xhaul into the overall 6G architecture.

- Integration of photonics and wireless systems including sensing.

- Protocols for the future end-to-end packet optical network architecture by taking into account adaptive multiband optical transmission, open and disaggregated optical networks.

- AI enhanced green optical networks and systems and AI enabled optical network automation as well as optical sensing for environment and networks.

- Enhanced trustworthiness with security enhancement and increased resilience.

The proposed activities should cover both R&I issues for low TRL topics and plan, towards the end of the SNS implementation, for demonstration of an end-to-end architecture, especially for very wideband use cases to demonstrate the overall energy consumption.

Necessary photonics components are expected to be provided by other initiatives such as Photonics 21 and/or Chips JU for use in the project, to exploit synergies between different initiatives.

Scope

The scope of this topic focuses on the following areas:
- Higher speed optical access networks and future end-to-end packet optical network architecture in all network domains to provide very high capacity and to support very wideband services and applications in an energy-efficient way.

- Architectures and protocols for access and backhaul use cases and potentially for optical space links in NTN systems, where the components and systems are developed in other initiatives but integrated in SNS platforms.

- Integration of wireless and optical and optical sensing as support for services.

- AI support for network automation and efficient use of resources with respect to energy consumption and efficiency.

- Quantum networking over fiber for trustworthy systems and applications.

- Impact of photonic systems in 6G on energy consumption / sustainability.

Note: Applicants should clearly identify the areas/priorities they address in case they only cover a subset.

HORIZON-JU-SNS-2025-STREAM-B-04: Reliable Services and Smart Security– Standardisation and Follow-up/PoCs

Specific Challenges and Objectives

6G is targeting more efficient interoperation between offered services and network operation, and more efficient and reliable service deployment. The multistakeholder, complexity and dynamicity of 6G networks impose strong needs for efficient run-time service development methodologies able to operate across multiple stakeholders in an efficient way, to provide complex, multi-technology, dynamic services. Moreover, optimized deployment considering aspects such as energy consumption, reliability and security levels are important topics for consideration. Thus, we need both new service development methodologies and novel instantiation processes.

These same features pose strong reliability challenges. Security, one of the dominant aspects of reliability, is not a single concern, but a thread woven throughout the entire digital infrastructures and services. From the cloud to AI and the network of IoT devices, each element presents unique vulnerabilities, participating to the threat landscape. This Topic is, therefore, targeting to address security following a holistic perspective, in order to achieve reliable service provision.

On a different dimension, research needs to investigate ways to leverage the benefits of open-source software while minimizing its security risks. This may require stronger collaboration among open-source developers, security researchers, and users to identify the whole life cycle process of OSS including certification fostering OSS potential usage in the landscape. Specific security focus on necessary open-source software for 6G network infrastructure shall be considered in-scope.

HORIZON-JU-SNS-2025-STREAM-B-04-01: Smart Security / Security Services

Call: HORIZON-JU-SNS-2025 (see Appendix 1)	
Specific conditions	
Expected EU contribution per project	The SNS JU estimates that an EU contribution of around EUR 8 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8 million.

Type of Action	Research and Innovation Actions
Eligibility conditions	Specific eligibility conditions apply and are described in Horizon Europe WP2023-25 General Annexes. Exceptions apply as detailed in the SNS R&I WP2025 Appendix 1 – Section 2.B (pending final decision).
Technology Readiness Level	Activities are expected to start at TRL 2-3 and to reach TRL 4 by the end of the project, and if/where relevant up to maximum TRL 5 (mature 6G technologies and solutions for verticals). Some parts of the project may only target TRL 3 by the end of the project.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The target outcomes address consolidation of results on:

- Availability, accessibility, and affordability of technologies supporting the necessary levels of resilience, openness, transparency, and dependability expected under the EU regulations (such as GDPR, Cyber Security Act and AI Act) across a complete service continuum, supporting complex human centric multimodal communications, including entangled devices.

- Availability, accessibility, and affordability of technologies ensuring secure, privacy preserving and trustworthy services in the context of a programmable platform for the complete life cycle of services, accessed by multi-stakeholders and tenants including vertical industries as users, for increasingly dynamic scenarios considering interdependencies between components and cascade effects that may be produced separately.

- Zero-touch security deployment solutions for virtualized and distributed environments, taking into account the varying computational capabilities and security requirements of their building blocks and their interactions with third-party entities.

- Algorithms, software and hardware implementations where appropriate, which can be used for PoC and later trials systems Dissemination of solutions for international consensus building, which can be exploited in standardisation activities.

- Impactful contributions to international standardisation.

Scope

The focus of this topic is on several complementary areas mentioned below and applicants may select one or more of these areas.

- Building secure 6G architecture integrating Security Services and Security attributes of 6G services. The topic deals with frameworks that will enable full life cycle service integration across multiple stakeholders. This encompasses, but not limited to, considerations for security evaluation, exposition of Security attributes, holistic composition of services in multi-provider environments, user centric monitoring/reporting capabilities.

- Secure services and security Services, including, but not limited to, user-centric security, advanced security schemes applicable to 6G APIs, intent-based security, with security policies extraction, seamless integration of Managed Security Service Providers into the 6G architecture.

- Security evaluation, including, but not limited to, continuous security assessment (in all phases of the system life cycle from development, including Safe code, DevSecOps to running phases), development of standardized metrics to evaluate security quality, design of appropriate certification frameworks, secure coding practices, vulnerability management during development, and secure deployment and update procedures.

Note: Applicants should clearly identify the areas/priorities they address in case they only cover a subset.

HORIZON-JU-SNS-2025-STREAM-B-04-02: Reliable Services Operation

Call: HORIZON-JU-SNS-2025 (see Appendix 1)	
Specific conditions	
Expected EU contribution per project	The SNS JU estimates that an EU contribution of around EUR 8 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 8 million.
Type of Action	Research and Innovation Actions
Eligibility conditions	Specific eligibility conditions apply and are described in Horizon Europe WP2023-25 General Annexes. Exceptions apply as detailed in the SNS R&I WP2025 Appendix 1 – Section 2.B (pending final decision).
Technology Readiness Level	Activities are expected to start at TRL 2-3 and to reach TRL 4 by the end of the project, and if/where relevant up to maximum TRL 5 (mature 6G technologies and solutions for verticals). Some parts of the project may only target TRL 3 by the end of the project.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The target outcomes address consolidation of results on:

- Efficient service operation methodologies able to operate across multiple stakeholders in an efficient way, to provide complex, multi-technology, dynamic services, catering to societal requirements (e.g. sustainability, privacy, AI-conformance).

- Service technologies for time-sensitive and computationally intensive applications, able to optimize deployment considering aspects as energy consumption, reliability and security levels; Low-overhead monitoring infrastructures and proper interfaces..

- Algorithms, software and hardware implementations where appropriate, which can be used for PoC and later trials systems. This includes aspects as failover and always-on technologies. Dissemination of solutions for international consensus building, which can be exploited in standardisation activities.

- Impactful contributions to international standardisation.

Scope

The focus of this topic is on several complementary areas mentioned below and applicants may select one or more of these areas:

- Automation and Intelligence in security operations, including, but not limited to, end-to-end attack detection and response in 6G with secure AI, mechanisms to ensure fully resilient infrastructures and services using self-healing and proactive defence methods, development of a dedicated Cyber Threat Intelligence (CTI) platform specifically tailored to the 6G.

- Service development methodologies, which inherently are able to support non-trustable providers and build reliable end-to-end services reliant in a variety of infrastructure providers, with different levels of reliability.

- Novel instantiation methodologies for run-time dynamics of service provision. New interfaces are expected to be proposed and developed, able to support the development of optimal algorithms addressing energy efficiency, privacy aspects, and AI-usage limitations. Technologies to increase the user ability to select the best solutions to cater to their needs are in scope.

- Interfaces, protocols and mechanisms to achieve cooperative remediation of various type of failures/attacks.

- Multistakeholder service auditing mechanisms, able to provide near-real-time information on the performance of the system(s), at different levels, from the end-user to the large network providers.

Note: Applicants should clearly identify the areas/priorities they address in case they only cover a subset.

HORIZON-JU-SNS-2025-STREAM-B-05: Microelectronic – Front-End Module (FEM)

As defined through the SNS – Chips JUs Microelectronic Workshop organized on 16.10.23[34],, the Front-End Module (FEM) was ranked as a first priority to be addressed. This Topic therefore targets one project on FEM, complementing the SNS Call 2023 Microelectronic projects and the SNS Call 2024 Microelectronic Lighthouse project. The FEM Topic has been designed to potentially span over the next Work Programmes to achieve critical mass and ideally to be mirrored by complementary activities under the Chips JU. It targets significant prospects for downstream industrialisation of the R&I results. The activities defined in this WP 2025 are hence considered for follow-up calls eventually leading to a transfer for validation to the Chips JU Pilot lines of relevance as a function of the selected technologies and design[35].

Specific challenges and objectives

The 5G application domain has already largely contributed to the development of new classes and capabilities of chipsets in the mobile communications domains (e.g., integrated RFIC's capable of handling mm Wave communications at low cost). 6G will push the envelope much further requiring specific developments for underpinning enabling technologies which include to cover application such as:

- The use of higher frequency spectrum above 71GHz, which is not available in current 5G standards. Sub-THz communications, above 90GHz, is contemplated for a range of applications such as "fibre like" backhaul (to support network densification) or multipoint access in industrial or high-density scenarios for Tbps connectivity target. The addition of upper mid-band spectrum "FR3" (7-15 GHz potentially extended up to

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

[35] See 3 years tentative planning in the report: "RESEARCH PRIORITIES ON MICROELECTRONICS FOR 6G NETWORKS R&I ACTIVITIES", at:

https://6g-ia.eu/wp-content/uploads/2024/02/6g-ia-position-paper_microelectronics-final.pdf?x21650

24GHz as a function of the ITU region of operations) which is considered as an industry priority to support higher data rate for 6G mobile devices whilst making possible intelligent sharing with incumbent services. This notably drives continued progress into the "Angstrom" era of CMOS to keep up with demands for low power compute/ high data rates/capacity and (AI assisted) signal processing to maximise sharing capabilities.

- New application like Integrated Communication and Sensing (ICAS) requiring integration of heterogeneous technologies, very wideband transceivers (>5GHz at Baseband), and support of moderate to high spectral efficiencies R&I which leads towards combined use of the same waveform (e.g. OFDM for the two applications) imposing different requirements on the underlying transceivers and hence extra complexity.

- Sophisticated industrial applications will drive the demand for integrated sensors and RF, optical and MEMS devices. Key requirements in this domain include larger data processing capabilities to cope with the bulk of edge data, integrated AI/ML processing for fast low latency filtering, and battery-less device capabilities for zero energy IoT devices.

Multiple applications, higher data rates and lower latency use case requirements further drives needs for SoCs that are designed to handle them. The challenge is to integrate various functions such as digital signal processing, memory, power management, massive arrays, beamforming capabilities and antenna systems as well as several technologies (RF, digital, power, packaging) into a packaged device, making them more efficient and cost-effective for the provision of layer 1 services for a spectrum range of interest. Ideally, this Front-End Module work should also form the basis for larger volumes through possible application at device level.

Call: HORIZON-JU-SNS-2025 (see Appendix 1)	
Specific conditions	
Expected EU contribution per project	The SNS JU estimates that an EU contribution of around EUR 12 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 12 million.
Type of Action	Research and Innovation Action
Eligibility conditions	Specific eligibility conditions apply and are described in Horizon Europe WP2023-25 General Annexes. Exceptions apply as detailed in the SNS R&I WP2025 Appendix 1 – Section 2.B (pending final decision).
Technology Readiness Level	Activities are expected to achieve TRL up to 5 by the end of the project
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The main outcome of the work is a comprehensive Front End module design which:

- Covers the FR3 range as defined by the relevant Agenda Item of WRC 27 (7 to 15 GHz range) with possible extension up to 24 GHz if required by some regional implementations.

- Covers promising use cases with possibility to support both cellular (FR1 like) and FWA (FR2 like) scenarios.

- Makes possible progress towards ITU IMT 2030 specifications, notably for what concerns maximum data rate, user data rate, spectral efficiency, whilst targeting 50% mobile transmission system energy consumption.

- Is based on technologies, architectures and implementations feasibility leading to European product developments and mass markets.

- Enables integration of heterogeneous classes of technologies, namely i) computing (e.g. CMOS, FDSOI); ii) RF (e.g. RF CMOS, RF SOI, FD-SOI, GaN-on-SiC, GaN-on-Si, InP, InP on Si, SiGeBiCMOS, SiGebipolar); iii) power generation technologies (e.g. GaN-on-SiC, GaN-on-Si, BCD, LDMOS).

- Leverages European strongholds in the above domains and is compatible with downstream Transfer to Chip JU Pilot lines.

- Addresses packaging.

- Covers frequency sharing and co-existence with incumbent services, notably satellites at FR3 range.

- Enables integration of secure sensing technologies and ISAC use-cases.

Scope

The scope of this topic focuses on the following areas:

- A FEM design that covers in priority FR3 frequency range, with possible extension to FR1 in case similar technological/implementation approaches are possible. Frequencies beyond 71 GHz (5G specifications upper end) are not in scope for this work.

- The characterisation and operational requirements of use cases that would most appropriately benefit from FR3 operations in the wireless domain, for both cellular use cases and FWA use cases, and their comparison with implementations at FR1 or FR2 respectively.

- The design of a complete FEM including a Digital Front End, a Radio Front End including antenna elements with the needed conversion stages and capable of handling at least 200 MHz channels. It enables high throughput/capacity fronthaul with performance capabilities close to those defined by the ITU 2030 Framework (ITU-R Recommendation M.2160-0) for peak data rates, user data rates and spectrum efficiency whilst enabling 50% energy savings of the transmission for a comparable bit rate conveyed by a 5G system.

- Smart integration of a multiplicity of heterogeneous technologies and modules with low loss characteristics at RF, digital, power levels and related packaging, leveraging Chip JU developments as appropriate notably for ultra-high transmit power/system Core technologies needed to develop high power/ high gain/low noise transceivers together with their coupling with CMOS/digital technology and enabling SoC implementation. Optical technologies may be in scope if compatible with an efficient FEM design and implementation, and further transfer towards Chip JU Pilot lines.

- Design supporting Integrated Communication and Sensing application and including secure ICAS specific functions at digital or RF level. It covers the implementation aspects of a combined Rx/Tx chain for JCAS with high node integration.

- Support of downstream high level of node integration for further transfer to Pilot Lines. A plan for development up to such transfer to the relevant Pilot Line(s) is expected.

- Evaluation of use of ML/AI for Tx/Rx for 6G performance and low cost, plus low energy consumption solutions. Analog neural networks processing technology may be considered for this domain, as appropriate.

- Minimisation of interferences and support of efficient interference control with incumbent users of the FR3 spectrum range, notably satellites. The work will address the needed control functions and their implementation. For this particular activity, related projects under the FEM Topic, the NTN Topic and the wireless R&I work are expected to closely cooperate.

- Implementation on SoC. Specific SoC architectures based on RISC V may be considered but should not be a mandatory requirement.

Note: To optimise the downstream implementation, the scope is open to several competing technologies and design. To that end, the work is expected to be backed with a very solid combination of European industrial leaders in the radio communication and microelectronic domains with adequate support from relevant academics and RTO's. The work may also consider existing FEM initiatives in Member States which should hence be compatible with wider industrial exposure in an EU collaborative environment.

Applicants should clearly identify the areas/priorities they address in case they only cover a subset.

HORIZON-JU-SNS - Stream C – Smart Network & Services experimental infrastructure

Notes: The Stream C work programme text (dedicated to the development of EU-wide experimentation platforms incorporating 6G telco cloud and service provision enablers) is considering the forthcoming HE Cluster 4 activities related to Connected Collaborative Computing Networks (3C networks) and other ongoing European activities (e.g. IPCEI-CIS, the Cloud-Edge-IoT HE projects etc.) to ensure complementarity and avoid potential overlaps.

The IPCEI-CIS aims to create innovative data processing solutions that rely on connectivity between data, sufficient bandwidth availability and ultra-low latency. IPCEI-CIS plans to achieve this by linking European data storage in a network of cloud and edge service providers and operating them in a decentralised manner. At the same time, IPCEI-CIS is improving the scalability and interoperability of application software and data originating from different infrastructure providers.

Relevant activities for large scale pilots for supply end to end infrastructures integration device, network computing and communication capabilities and for Telco Edge Cloud deployments as a basis for Connected Collaborative Computing Networks (3C Networks) have been proposed for consideration by the EC through the White paper "How to master Europe's digital infrastructure needs?".[36]

The SNS Stream C work programme 2025, taking into consideration the aforementioned initiatives, and the results of previous and/or ongoing SNS projects, targets a coherent long-term HE plan on telco cloud continuum. Its target is to develop the necessary 6G telco cloud experimental infrastructure mainly focusing on mid-TRL (up to TRL 5) to provide the means

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[36] https://digital-strategy.ec.europa.eu/en/library/white-paper-how-master-europes-digital-infrastructure-needs

for further integrating SNS JU solutions (e.g., from past and/or ongoing SNS projects) and test them in future SNS Stream D trials. The role of this infrastructure is to be used for quick testing and validation of 6G solutions to eventually increase their TRL level and provide the results and solutions to future EU initiatives that will adopt and integrate them in operational networks.

Specific Challenges and Objectives

Cloud solutions are becoming an integral part of future systems. Starting from 5G networks, the current trend is to create a cloud continuum that refers to a seamless integration of computing resources across different domains. This continuum enables efficient data processing, minimizing latency, saving bandwidth, improving security, ensuring privacy, and enhancing autonomy. This continuum is expected to introduce higher levels of flexibility for the seamless deployment, integration, composition provision, and management of 6G infrastructures and services. The importance of cloud solutions and the seamless deployment, integration, composition provision, and management of services will be significant for the European telecommunications industry. All network domains will need computing infrastructure (potentially highly distributed, from device and edge/far edge to centralised data centres), to deploy and execute different network functions.

Due to the cloudification of the networks and the lack of standardized European alternatives, current limited implementations rely on proprietary cloud solutions provided either by hyperscalers or based on own developments. For Europe it is vital to take cloud sovereignty into account in this ongoing cloudification process. This includes the compute, transport and storage of data that need to remain under domains that are controlled or conform to EU jurisdiction and legislation.

Also of relevance is the fact that, if designed properly, this further disaggregation of cloud facilities may alter the existing business models. For facilitating business innovation new telco cloud solutions for Europe should be based on flexible open-source solutions and trustful standardized interfaces among services, clouds, networks, and computing resources. This is the more viable solution to create an open market where multiple cloud service providers (including the operators) will offer their services openly and fairly, potentially supporting innovative business models. Standardized interfaces will also enable the operators to select specific services not only from hyperscalers, but also the multiple stakeholders that such an open ecosystem brings (e.g., RAN providers, transport providers, function providers, AIaaS providers), more modularly and even switch from one provider to another when they want to. Standardized interfaces will also allow user mobility among infrastructure and cloud providers seamlessly (e.g., mobility of users among edge cloud providers). Such an approach can guarantee that European policy priorities such as technological sovereignty, security, and privacy are safeguarded with a plethora of technical and business models underlying them.

Moreover, until today, European Operators have made considerable investments to increase the capacity of their networks by acquiring spectrum and updating their equipment from one generation of cellular networks to the next, tackling the constantly growing traffic needs. To further address this point, further work is needed to extend the functionalities offered by the (east/west and northbound) interfaces in a standardized way. This way, European operators may a) expose part of their operation to the vertical service providers, b) offer services that can be offered only by themselves (e.g., AI as a service), based on the wealth of data they have, and c) facilitate innovation from third parties, enabling a vibrant differentiated ecosystem for the cloud continuum.

Europe is taking steps forward with various initiatives (e.g., IPCEI-CIS, Cluster 4) targeting to deliver operational solutions. The SNS JU is working with a forward-looking approach investigating how 6G features and capabilities will further guide the evolution of the telco cloud continuum.

The goal for Stream C is to create an R&D 6G telco cloud pan European platforms combined with service provision enablers that can be used to test and experiment with candidate 6G technologies and enablers.

The Stream also offers opportunities to include and extend additional platforms developed in other related national initiatives, Cluster 4 projects (e.g., under the "Advanced computing and big data"[37] domain) IPCEI-CIS[38], or previous SNS projects. e.g. by expanding the work of SNS platforms from previous Calls.

The main objective of this Stream is hence to prepare the development of 6G test EU telco cloud and service provision infrastructure based on open-source solutions, with the clear target to have a substantial impact in standardisation and assist in the further evolution of relevant existing open-source activities or even trigger the creation of new one. The long-term target of the projects will be to provide solutions that will be integrated and extend the capabilities of ongoing EU activities on telco-cloud so that these will eventually be used by commercial European networks, whilst paving the way towards 6G architecture and service implementation.

As in previous Stream C calls, related objectives include:

   a) <u>Reusability and evolvability of the experimental platforms over the lifetime of the SNS programme</u>: Platforms or specific components can be (i) further extended to ensure a continuous integration of the most promising 6G technologies and (ii) capable of supporting downstream Stream D projects where appropriate.

   b) <u>Accessibility and openness</u>: Use of the platform in subsequent phases of the SNS by any consortium, requires using a modular implementation methodology and, open-source solutions with well-defined and documented technological and business interfaces.

   c) <u>Directionality and optimisation of previous and related investments in Europe</u>: 6G experimental platforms leveraging previous investments in Europe may be considered including other technology-oriented initiatives on open ecosystems (e.g., Open RAN). Leveraging 6G investments by Member States or Associated countries is also relevant in this context. Although it is not a mandate to reuse the results from previous investments, the proposal should clearly identify how it will extend these platforms to support 6G features and capabilities.

   d) <u>Disruption friendly</u>: Experimental facilities should be capable of hosting possible future 6G technological disruption and hence guarantee their future-proofness.

   e) <u>End-to-end</u>: The target experimental facility should preferably demonstrate E2E service capabilities and include entire value chain including IoT devices, connectivity, and service provision.

Activities are expected to reach TRL 5 by the end of the project.

HORIZON-JU-SNS-2025-STREAM-C-01: 6G Telco Cloud and Service Provision Enablers

Call: HORIZON-JU-SNS-2025 (see Appendix 1)
Specific conditions

[37]https://cordis.europa.eu/search/en?q=contenttype%3D%27project%27+AND+programme%2Fcode%3D%27 HORIZON.2.4.7%27&srt=/project/contentUpdateDate:decreasing

[38] https://ec.europa.eu/competition/state_aid/cases1/202412/SA_102517_707E5C8E-0000-C216-8C1C-3081176554C2_287_1.pdf

Expected EU contribution per project	The SNS JU estimates that an EU contribution of around EUR 15 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 15 million.
Type of Action	Research and Innovation Action
Eligibility conditions	Specific eligibility conditions apply and are described in Horizon Europe WP2023-25 General Annexes. Exceptions apply as detailed in the SNS R&I WP2025 Appendix 1 – Section 2.B (pending final decision).
Technology Readiness Level	Activities are expected to achieve TRL up to 5 by the end of the project.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The main outcome will be the availability of an evolvable 6G telco cloud and service provision experimental infrastructure for the duration of the SNS programme that covers relevant capabilities to:

- Develop a multi-provider and multi-technology system that hosts and manages network functions, considering key 6G features like deterministic networking, as well as functions beyond connectivity (e.g., AI as a service, Compute as a Service, Security as a Service, ISAC as a service, etc.), integrated into the telco system or independent from the telco system, and any other application or capability as a service.

- Validate/demonstrate 6G telco cloud and 6G architecture (as developed or under development in the scope of the SNS JU), 6G technologies for service provision and systems as part of a representative end-to-end infrastructure, building open-source principles with a high potential to be used by European commercial and operational networks.

- Take advantage of and extend results/outcomes from past and ongoing European Initiatives e.g. the IPCEI-CIS, the Cluster 4 activities on advanced computing and big data and the anticipated potential Cluster 4 initiatives on large scale pilots, with the clear target to provide 6G solutions for telco cloud and service provision; Develop synergies with other European and national projects.

- Validate/demonstrate feasibility of 6G KPIs, related indicatively to capacity, ubiquity, speed, latency, reliability, density of users, location accuracy, energy efficiency, security, service creation time, network management CAPEX/OPEX.

- Enable innovative 6G research across numerous technical areas including radio development for advanced networks including 6G Radio Access Network (RAN) architectures, network orchestration models, Massive MIMO, etc.

- Integrate full value chain experiments covering IoT/devices, connectivity, and service delivery as well as the seamless support of users served by multiple service providers.

- Support efficiently 6G distributed services, service migration and intelligent orchestration.

- Support the demonstration of the feasibility of key societal requirements and objectives such as energy reduction at both platform and use case levels, sustainability, social

inclusivity, safety and security, trust and resilience. Other key societal indicators indicatively include coverage, accessibility and affordability of the technology.

- Impact the SNS upstream use of the developed technology to ensure the continued support for the requirements of the 6G system in the fundamental technologies used.

Stakeholders should commit that the result will be easily replicated in the same or additional locations/countries if this platform is selected for trials as part of future Stream D projects or in HE Cluster 4 activities.

The target experimental infrastructure and its modules should be open and accessible for a long enough period to allow for an easy handover from one SNS phase to the other. Conditions should allow this infrastructure to be easily reused under fair and reasonable conditions for subsequent phases of the SNS programme implementation.

In view of ensuring maximum take up of the validated technologies, proposals should include a significant representation of European players with strong demonstrated impact at standardisation level, contribution to the relevant open-source activities and strong potential of monetizing the produced solutions.

Scope

The target 6G experimental infrastructure provides the capability to support the demonstration and operational validation of the most ambitious 6G use-case scenarios as deriving from the European 6G vision. The target experimental platform should therefore include Continuous Integration (CI) testing Continuous Development (CD) and validation capabilities at every relevant layer for the telco cloud, covering disaggregated scenarios like Open architectures, blurring the boundaries between RAN, edge and core. End-to-end virtualisation, network slicing and softwarization are key components to support multi-tenant environments, integration of private/non-public and public networks as well as multiple vertical use cases. Coverage includes the device and IoT integration and the cloud edge capabilities with scale-up capabilities for demanding services, based on a clear EU strategy for an edge integration into a complete cloud continuum, following open-source principles with a high potential to be up-taken later by European commercial telecommunication networks.

The scope includes an open, disaggregated, versatile, and unified end-to-end platform supporting the dynamic provision and management of OTT and other services, operating over multiple interconnected 6G sites in multiple European countries and following open architectures at cloud implementation level, thus delivering the highest degrees of performance, flexibility and functionality.

The target platform's demonstration/operational capabilities are to be assessed against 6G KPIs and Sustainability targets (e.g., KVIs) as defined by the SNS JU. Proposals should be flexible to accommodate new relevant KPIs as they become available from the wider 6G community and potential use cases.

To provide the required openness to host vertical use case pilots, the platforms should support open framework principles (e.g., both legal and technical like open APIs) enabling future vertical projects to access and use them. It is also strongly desirable that these facilities are built in a way that allows the evaluation of competing technologies, where appropriate. Openness is also a key requirement for "partial implementation" of demonstration capabilities. In that case, well-defined infrastructure and service interfaces will have to be defined in view of their interoperability with complementary platforms.

Innovative research across numerous technical areas including radio development for advanced networks including Radio Access Network (RAN) architectures, network orchestration models, Massive MIMO, and beyond are in scope with relevant support of state-

of-the-art radio, compute, storage, and cloud resources. It includes ultra-high-bandwidth and low-latency wireless communications, with tightly coupled edge computing.

The scope of the project should include the below areas:

- Develop a Service Platform (both network services and user services) and Telco Edge Cloud, including Far Edge and Near Edge integration, leveraging and influencing Open-Source developments.

- Develop telco cloud solutions taking into consideration 6G technologies, features, and components at system or sub-system level, with clear objectives towards their adoption at standardisation and eventually at market level.

- Integrate in the telco cloud continuum 6G features and capabilities in view of supporting new 6G RAN capabilities (e.g. Hexa-X-II model) with minimum implementation options and demonstrate the validity of this evolutionary approach with minimum implementation options.

- Show the applicability of such telco cloud technologies to efficiently support advanced 6G applications and use cases not already supported by current 5G and 5G Advanced systems whilst contributing to core KVI's, notably sustainability.

- Develop solutions and demonstrate the efficient, cloud native management of the platform and its telco applications.

- Develop solutions and demonstrate the platform capability to support AI native solutions.

- Provide 6G telco cloud solutions to deliver the required performance in an efficient and sustainable way (e.g., in terms of energy management, carbon impact).

The proposed solution should rely on existing or new open-source efforts like GSMA (e.g., Open Gateway[39]), TIP (e.g. OpenRAN[40]), as well as open-source projects (e.g., Sylva[41], Anuket[42], Open Nebula[43], CAMARA[44], ETSI hosted[45], Nephio, CNCF, LFN etc.). In addition, this work may influence existing or new open-source projects (such as the above mentioned) to ensure that the new requirements of the 6G system are supported by the relevant open-source technologies. The selected project should also provide further enhancements on network exposure and secure service distribution and digital trust. It should also provide solutions for AI-driven/supported service marketplace (catalogue of services) – standardizing a multi-stakeholder communication. In this Topic, instantiations, exposure functions, allowing exposition of available resources and required/value-added service attributes (performance, security, sustainability) related to the user applications and getting semantics of the requirements from user applications explicitly or implicitly, as well as discovery capabilities should be considered. The work is targeting to extend the capabilities of existing solutions to address 6G targets, and not simply re-use them.

HORIZON-JU-SNS - Stream D – SNS Trials and Pilots (T&Ps) with Verticals

Specific Challenges and Objectives

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[39] https://www.gsma.com/solutions-and-impact/gsma-open-gateway/

[40] https://telecominfraproject.com/openran/

[41] https://sylvaproject.org/

[42] https://anuket.io/

[43] https://opennebula.io

[44] https://camaraproject.org/

[45] https://www.etsi.org/committees

The objective is to validate 5G Advanced and 6G technologies in a user context to further enable successful take up by vertical sectors. While in previous WPs we focused in assessing widespread technology usage with the coverage of many verticals under one project, in this WP we aim the in-depth study of existing (potentially single) vertical pain-points to adopt 5G advanced and 6G solutions with the ultimate target that the produced solutions will have a very high prospect to be used by the vertical sectors in the near future. This Stream targets:

- The contribution to the creation of ecosystems with verticals identifying real business pain points and how these can be addressed by advanced technological solutions.

- The engagement with an appropriate number of key vertical stakeholders to provide mature solutions that will provide clear business benefits and will have high probability of wide usage, exploitation and exploitability from specific vertical industries after the completion of the project.

- The validation of SNS KVIs[46] and KPIs in the context of very advanced digital use cases implemented through Trials and Pilots (T&P) for public and private deployments. Stream D projects in this WP are not targeted to be large scale, but expected to focus on specific vertical sectors, specific use-cases and a limited set of locations. The focus for Stream D projects should be on the experimental validation and the support to monetize 6G services and applications for verticals.

- The evaluation, measurement, and testing of ICT technologies enablement effect and impact in different and complex ecosystems.

- A structured feedback loop from vertical users towards SNS stakeholders, in view of ensuring the best match between 5G Advanced / 6G systems capabilities and users.

- An integrated validation approach, from 6G platform to use cases, leveraging existing (open) platforms (e.g., developed under previous SNS or National calls).

- Accessibility and openness: The required technology deployments to support specific Stream D use cases, should be reusable to any consortia in future Calls and phases of the SNS JU. This approach requires using a modular implementation methodology, potentially open-source solutions with well-defined and clearly documented technological and business interfaces.

A related ancillary target is to leverage relevant 5G Advanced / 6G solutions available from the SNS JU and other European initiatives, also at the national level (and where possible from partners that contribute to national level and SNS projects), in this field. Stream D projects are thus expected to benefit from identified 6G enablers (technological enablers such as Joint Communication and Sensing AI/ML, cybersecurity, Cloud continuum, advanced IoT solutions as well as societal enablers such as inclusivity, energy efficiency, economic growth) and 6G solutions from previous SNS Calls. Following the overall SNS R&I WP structure, Stream D projects are expected to build solutions mainly based on Stream B, C and D project results from previous calls or based on SNS projects solutions explored for verticals. Thus, for Stream D projects being implemented over past SNS infrastructures or PoCs, platform enhancements may be necessary for the specific target use case. In such cases, those enhancements are expected to follow the same requirements as expressed for experimental platforms, in particular openness, reusability, and accessibility. Moreover, Stream D projects may consider capitalising on related solutions that will be developed under EC HE Cluster 4 on Cognitive Cloud and IoT, or other EU initiatives (e.g., national initiatives, IPCEI-CIS etc.).

The proposals may also strategically consider potential high-level exposure of European capabilities and leadership in technologies towards 6G through support of future potential

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[46]https://www.sciencedirect.com/science/article/pii/S0308596124000752

large showcasing events, e.g. sports events like UEFA EURO 2028, Winter Olympic games 2026 / 2030, Summer Olympic games 2028 etc.

The use cases that will be addressed by the verticals shall consider how the used 5G Advanced and 6G technologies are embracing sustainability aspects, considered from an environmental, societal and economic sustainability perspective.

This Topic targets 4 projects, which are expected to prioritize use cases for a limited number of verticals (1 or maximum 2 verticals) to ensure that they engage key vertical stakeholders and provide solutions of high monetization prospects, e.g. according to the European vision and orientations[47], as presented in the 3GPP SA1 Workshop that took place in May 2024.

The key project targets are the following ones (not mutually exclusive):

- Prepare the vertical industries for the benefits of 6G networks.

- Validate architectural solutions/orientations for the support of vertical industries.

- Identify current pain-points for the adoption of 6G technologies and provide directions on how these can be addressed.

- Facilitate the creation of an initial business ecosystem for 6G solutions for verticals.

- Deliver close to market business solutions/services to be used by verticals.

HORIZON-JU-SNS-2025-STREAM-D-01: SNS Trials and Pilots (T&Ps) with Verticals

Call: HORIZON-JU-SNS-2025 (see Appendix 1)	
Specific conditions	
Expected EU contribution per project	The SNS JU estimates that an EU contribution of around EUR 6 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 24 million.
Type of Action	Innovation Actions
Eligibility conditions	Specific eligibility conditions apply and are described in Horizon Europe WP2023-25 General Annexes. Exceptions apply as detailed in the SNS R&I WP2025 Appendix 1 – Section 2.B (pending final decision).
Technology Readiness Level	Activities are expected to achieve TRL 5-7 by the end of the project.
Funding rate	100% non-for-profit organizations, 70% for profit organizations

Expected Outcome

The key target of Stream D projects will be to qualify, quantify and test advanced 5G/6G technologies enablement effect and impact in and for vertical sectors. Where relevant, the projects should aim to take advantage of developed platforms and/or elements from previous

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[47] https://www.3gpp.org/ftp/workshop/2024-05-08_3GPP_Stage1_IMT2030_UC_WS/Docs/SWS-240018.zip

SNS Stream B, C and D projects, and if needed, up-grade them to keep them operational for next SNS phases, as well as platforms developed in the context of national initiatives or any other EU based solutions that integrate and offer preliminary 6G network solutions. It is relevant in this context all the computing platform initiatives being developed at national and international level.

The key expected outcomes are:

- Evaluation, measurement and validation of advanced 5G/6G technologies.

- Contribution to the further refinement of seamless E2E 6G test infrastructures with fine-tuned capability to integrate vertical use cases specific performance/KPI and KVIs requirements, as applicable also across public and non-public networks and services.

- Validated infrastructure core technologies and architectures, for public and private deployments, across the value chain in the context of vertical trials and pilots use-case implementations and relevant deployment scenarios targeting tangible sustainability results (in terms of societal, business and environmental aspects).

- Viable business models for innovative digital use cases tested across various vertical sectors.

- Mature solutions of high potential to be adopted from verticals after the completion of the project.

- Support to impactful contributions towards standardisation bodies notably for 6G use cases and technologies, including KVIs.

- European 5G Advanced and 6G know-how showcasing. Visible events widely open and inclusively accessible to the public are particularly relevant.

- Onboarding of vertical stakeholders, SMEs and the European Academic and Research community to engage in experimental activities in a timely fashion, aimed to validate technological trends.

- Collection of requirements from verticals and collection of "lessons learned" to prepare for subsequent phases of the SNS programme.

- Contribution to a repository of open-source tools and modules that may be openly accessed and used by SNS projects over the programme's lifetime.

Scope

The projects are expected to cover at least:

- Demonstration of clear benefits for a limited number of verticals (i.e., 1 or maximum 2 verticals per project) with stakeholders of the considered 5G advanced/ 6G technologies and architectures in terms of innovative 6G smart networks and services addressing multiple aspects (e.g., scalability, security, resilience and performance improvements) in line with medium to long-term diverse socio-economic scenarios.

- Special focus on targeting and achieving, tangible results for environmental, societal and economic aspects by the end of the project.

The applicants should select their targeted vertical sectors according to the project objectives and use-cases, considering the vertical priorities for (1) Industry/Manufacturing (including robotics), (2) Media (including gaming, broadcasting…), (3) Transportation/Logistics, (4) Emergency and Safety Services and (5) Health (indicative order not prioritized). The afore verticals to be considered should be in line with the European view on 6G use-cases that were presented during the 3GPP SA1 Workshop in May 2024. The projects are expected to focus on specific verticals sectors (one or maximum two verticals per project, in the case of existing

commonalities/complementarities between the selected two verticals; nevertheless, if addressing two verticals, applicants should still clearly indicate the centre of gravity, i.e. the main vertical of the project, for evaluation purposes).

Note: To ensure a balanced portfolio within Stream D and to guarantee that the approved projects will have different centres of gravity from the above 5 vertical priorities, grants will be awarded to applications not only in order of ranking but at least also to one project that is the highest ranked within each of the above vertical priorities, provided that the applications attain all thresholds (and subject to available budget). Only the centre of gravity vertical area will be considered in terms of topic coverage during the evaluation process. See General call conditions, section 2.F of Appendix 1.

The trials and pilots should be carried out from an end-to-end perspective, with representative technologies covering the full value chain, including devices, connectivity, and service delivery. They should demonstrate the integration of different IoT/cloud/edge/computing environments (public and/or private) towards a distributed environment and dynamic resource needs with a landscape unified management able to support the emergence of a European offer and capability.

Strong involvement of SMEs is targeted in the projects. These actors are expected to play a key role in this process with new market-driven applications that can build value on the 5G/6G infrastructure. This support will be a critical enabler of European-led innovation, fast track adoption, and stimulation of private sector investment, across verticals.

The performance and sustainability capabilities (in terms of business, societal and environmental aspects) are to be assessed against related KVIs and KPIs. Proposals should clearly indicate the target set of KPIs and KVIs and how this advances the state of the art. Performance improvement in all domains requires definition of a benchmark against which improvements may be evaluated. Cross-project collaboration is needed to define such a benchmark that will be part of the target outcome KPI repository of the SNS JU. It is expected that software entities implement the target services in Open-Source Code and with open interfaces for further reutilisation in subsequent SNS phases and on further vertical domain activities. Outputs of the work is expected to demonstrate the applicability of 6G KPI/KVI to specific use case requirements, i.e., to map those with higher level requirements at application level.

SNS T&Ps are expected to attract the participation of key vertical industries in view of stimulating a strong European participation in future downstream standardisation phases. Therefore, participation of vertical and industrial actors with demonstrated strong standardisation impact is desired. It is equally important that the projects will engage key vertical stakeholders for monetising/valorising project results towards their adoption in the respective vertical sectors.

The Stream D projects should take advantage, where applicable, from already developed platforms and/or elements from the SNS previous Phase 1 & Phase 2 Stream B, C and D projects, platforms developed in the context of national initiatives or any other solutions that integrate and offer preliminary 6G network solutions (e.g., IPCEI-CIS). It is expected that specific adaptation/development work on the SNS or National Platforms, or any related solutions from other EC HE Cluster 4 activities, will be included in the projects under this Stream, in order to achieve the related ambitions/targets.

Appendix 1: SNS 2025 Call overview and General call conditions

Notes:

    i)   An overview of the SNS 2025 call is provided at Section 1 of this Annex II to the SNS Joint Undertaking Work Programme 2025.

    ii)   The SNS 2025 general call conditions are based on the "General Annexes for Horizon Europe call conditions 2023-2025[48], with some exceptions and clarification that are specific to SNS and outlined in this Appendix to the Annex II to the SNS Joint Undertaking Work Programme 2025.

    iii)   Support to Stakeholders and applicants for this call will be provided through a regularly updated list of "Frequently Asked Questions", FAQ's, made available on the SNS JU website (link will be also available on the F&T portal).

    iv)   The below additional conditions refer to one SNS Call within 2025. If, at a later stage, there is a Governing Board decision to split the SNS 2025 Call into two smaller Calls, all implementation modalities (e.g. opening dates and submission deadlines) will be defined via an amendment to this WP Appendix.

1. SNS 2025 Call

Call identifier: HORIZON-JU-SNS-2025

Overview of the call

    Type of call: single stage call

    Opening date: January 2025

    Submission of Proposals deadline: mid to end April 2025 17:00:00 (Brussels local time)

    Proposals are invited against the Streams and topics set out at **Table App 2** below.

    Overall indicative budget: EUR 128 million

    General conditions relating to this call: see part 2 of this Appendix 1.

Estimated value of the In-Kind contributions to Operational Activities (IKOP) by the members other than the Union or their constituent entities: Minimum EUR 8 million. A minimum programme level IKOP contribution of 6% is targeted and proposals are expected to significantly contribute to this target (see section 1.4 for related evaluation sub-criterion).

NB: For proposals submitted under the various Streams of this work programme and considering past average participation per type of beneficiary (profit & not-for-profit members -or non-members- of 6G-IA) the table below outlines how the IKOP target at Programme level is converted in minimum values:

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[48] https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/horizon-europe-work-programmes_en

Table App 1

Streams / Topics	Indicative IKOP level as % of project budget to reach the objective.
HORIZON-JU-SNS-2025-STREAM-B (RIA)	
01-01: Advanced Architectures Systems and Technologies	**2,4%**
01-02: Advanced IoT and Device Technologies	
02: Wireless Communication Technologies and Signal Processing	
03-01: 6G NTN-TN Unification/Integration	
03-02: Higher Speed Optical Access Networks and future end-to-end Packet Optical Network Architecture in 6G	
04-01: Smart Security / Security Services	
04-02: Reliable Services Operation	
05: Microelectronic – Front-End Module (FEM)	**3,6%**
HORIZON-JU-SNS-2025-STREAM-C (RIA)	
01: 6G Telco Cloud and Service Provision enablers	**3,6%**
HORIZON-JU-SNS-2025-STREAM-D (IA)	
01: SNS Trials and Pilots (T&Ps) with Verticals	**19,50%**

In Kind Contribution to Operational Activities (IKOP) are defined in Article 2 (8) of the Council regulation (EU) 2021/2085 establishing the Joint Undertakings under Horizon Europe[49] as follows:

"i*n-kind contributions to operational activities mean contributions by private members, constituent entities or the affiliated entities of either, by international organisations and by contributing partners, consisting of the eligible costs incurred by them in implementing indirect actions less the contribution of that joint undertaking and of the participating states of that joint undertaking to those costs;"*

For all SNS streams applicants will be invited to fill a mandatory IKOP declaration table in the Application Form Technical Description (Part B).

Target for SME participation is at 20% at programme level. Proposals are expected to contribute to this target as appropriate, see section 1.4 for related evaluation sub criterion.

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[49] http://data.europa.eu/eli/reg/2021/2085/oj

Table App 2

Streams / Topics	Call 2025 Indicative Topic Budget (in M€)
HORIZON-JU-SNS-2025-STREAM-B (RIA)	
01-01: Advanced Architectures Systems and Technologies	15.0
01-02: Advanced IoT and Device Technologies	9.0
02: Wireless Communication Technologies and Signal Processing	21.0
03-01: 6G NTN-TN Unification/Integration	8.0
03-02: Higher Speed Optical Access Networks and future end-to-end Packet Optical Network Architecture in 6G	8.0
04-01: Smart Security / Security Services	8.0
04-02: Reliable Services Operation	8.0
05: Microelectronic – Front-End Module (FEM)	12.0
HORIZON-JU-SNS-2025-STREAM-C (RIA)	
01: 6G Telco Cloud and Service Provision enablers	15.0
HORIZON-JU-SNS-2025-STREAM-D (IA)	
01: SNS Trials and Pilots (T&Ps) with Verticals	24.0
Total (M€)	**128**

2. General call conditions

The SNS JU operates under the Horizon Europe Rules for Participation, set out in Regulation (EU) (EU) 2021/695 of the European Parliament and of the Council of 28 April 2021 laying down the rules for participation and dissemination in "*Horizon Europe - the Framework Programme for Research and Innovation (2021-2027)*" and repealing Regulation (EU) No 1290/2013 and (EU) No 1291/2013 (EC) and (EU) No 1291/2013.

The general conditions outlined in this Section are complementary to the basic conditions outlined in the table provided in the definition of each funded topic of the SNS 2025 call. Further, ff a topic deviates from the general conditions or includes additional conditions, this is explicitly stated under the specific conditions for the topic.

A. Admissibility

General Annex A of the General Annexes to the Horizon Europe Work Programme 2023-2025 shall apply *mutatis mutandis* to the SNS call 2025 covered by this Work Programme, with the following derogations to page limits:

The limit for a full proposal is **70 pages for RIAs** submitted under Stream B, C, **and for IAs** submitted under Stream D.

B. Eligibility

General Annex B of the General Annexes to the Horizon Europe Work Programme 2023-2025 shall apply *mutatis mutandis* to the SNS call 2025 covered by this Work Programme, with the following exceptions or amendments:

Note: The eligibility text regarding restrictions on participation or control (application of Article 22(5) of the Horizon Europe Regulation) may be amended to consider the conclusion of the ongoing Commission procedures and discussions between Commission Services and Members States' Representatives in the SRG.

i) Restrictions on participation in accordance with Article 22(5) of the Horizon Europe Regulation

ii) Restrictions for the protection of European communication networks

The provision applies in accordance with General Annex B of the General Annexes of the Horizon Europe Work Programme 2023-2025[50]. In order to meet the requirements specified therein and in this WP section Context and Objectives (Protection of European Communication Networks as EU policy objective), entities that are assessed as high-risk suppliers of mobile network communication equipment (and any entities they own or control) are not eligible to participate as beneficiaries, affiliated entities and associated partners.

iii) Minimum participation of SNS JU member (other than the Union) in the below Streams, mainly intended to support IKOP generation:

Table App 3

Actions	Restriction	Justification	Note

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[50] wp-13-general-annexes_horizon-2023-2024_en.pdf

HORIZON-JU-SNS-2025-STREAM-B-05	At least half of the budget should be implemented by the SNS JU member (other than the Union)[51] and their constituent or affiliated entities.	In line with Recital 21 and Article 5.2.(a) of the Council regulation (EU) 2021/2085 establishing the Joint Undertakings under Horizon Europe. IKOP generation with long term commitment of partners and JU members other than the Union, including players from the microelectronics sector. It requires to be established and steered with long term commitment of partners and of JU member other than the Union. The activities are also supporting the objectives of the Chips Act, the IPCEI ME/CT and targets cooperation between SNS and Chips Joint Undertakings towards microelectronics for 6G.	Up to half of the budget fully open
HORIZON-JU-SNS-2025-STREAM-C-01	At least half of the budget should be implemented by the SNS JU member (other than the Union) and their constituent or affiliated entities.	In line with Recital 21 and Article 5.2.(a) of the Council regulation (EU) 2021/2085 establishing the Joint Undertakings under Horizon Europe. IKOP generation with long term commitment, including players from the cloud sector, and required stability as needed to develop a long-term plan	Up to half of the budget fully open

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[51] The SNS JU member other than the Union is the 6G Smart Networks and Services Industry Association (6G-IA) https://6g-ia.eu/

		on telco cloud continuum and experimentation infrastructure that spans the programme lifetime. It requires to be established and steered with long term commitment of partners and of JU member other than the Union. This is needed to provide the means for further integrating SNS JU solutions and test them in future SNS trials with sufficient stability. The activities are also supporting the objectives of the EC White Paper "How to master Europe's digital infrastructure needs?" and targets cooperation with the forthcoming activities under Horizon Europe Cluster 4 –in the context of Connected Collaborative Computing Networks (3C networks) and other ongoing European activities (e.g. IPCEI-CIS, the Cloud-Edge-IoT HE projects etc.).	
HORIZON-JU-SNS-2025-STREAM-D-01	At least 70% of the budget should be implemented by the SNS JU member (other than the Union) and their	In line with Recital 14, 21 and Article 5.2.(a) of the Council regulation (EU) 2021/2085 establishing the Joint Undertakings under Horizon Europe. Large scale trials require	Up to 30% of the budget fully open

	constituent or affiliated entities.	take up commitments from JU private member constituents or affiliated entities. The Innovation Actions, with higher TRLs, will leverage and complement the programmatic large-scale platform for test and validation of critical technologies and will be enhanced over time. This requires a long-term commitment of the participating entities and from the JU member other than the Union.	

For the above Streams (Table App 3), applicants will be invited to fill a **mandatory table of compliance** at proposal stage in the **Application Form Technical Description (Part B).**

Proposals that do not fulfil the above Table App 3 conditions, including the mandatory table of compliance, at the time of the proposal submission, will be considered ineligible and, therefore, will not be evaluated.

iv) Gender equality plans and gender dimension of R&I:

According to the General Annexes, provision of a gender equality plan for public bodies, research organisations or higher education establishments (including private research organisations and higher education establishments) applies as per Part B of the General Annexes to the Horizon Europe Work Programme 2023-2025.

Additional gender issues (related to award sub-criterion consideration of the gender dimension in research and innovation content) shall be addressed as appropriate in case research results are expected to differ when applied to different gender populations of users.

v) Legal entities established in Russia, Belarus, or in non-government-controlled territories of Ukraine

Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, there is currently no appropriate context allowing the implementation of the actions foreseen in this programme with legal entities established in Russia, Belarus, or in non-government-controlled territories of Ukraine. Therefore, even where such entities are not subject to EU restrictive measures, such legal entities are not eligible to participate in any capacity. This includes participation as beneficiaries, affiliated entities, associated partners, third parties giving in-kind contributions, subcontractors or recipients of financial support to third parties (if any). Exceptions may be granted on a case-by-case basis for justified reasons. With specific regard to measures addressed to Russia, following the adoption of the Council Regulation (EU) 2024/1745 of 24 June 2024 (amending Council Regulation (EU) No 833/2014 of 31 July 2014),

legal entities established outside Russia but whose proprietary rights are directly or indirectly owned for more than 50% by legal persons established in Russia are also not eligible to participate in any capacity.

C. Financial and operational capacity and exclusion

General Annex C of the General Annexes to the Horizon Europe Work Programme 2023-2025 shall apply *mutatis mutandis* to the SNS call 2024 covered by this Work Programme.

D. Award criteria

General Annex D of the General Annexes to the Horizon Europe Work Programme 2023-2025 shall apply *mutatis mutandis* to the SNS call 2025 covered by this Work Programme with the following complements:

For RIAs under Streams B, C and IAs under Stream D, the award criteria table is complemented as follows:

 - Introduction in the impact section of a sub-criterion assessing the proposal contribution to the overall SME objective as appropriate;

- Introduction in the impact section of a sub-criterion assessing the proposal contribution to the IKOP objectives;

Table App 4

	Excellence (The following aspects will be taken into account, to the extent that the proposed work corresponds to the description in the work programme)	**Impact**	**Quality and efficiency of the implementation**
Research and innovation actions (RIA) **Innovation actions (IA)**	- Clarity and pertinence of the project's objectives, and the extent to which the proposed work is ambitious and goes beyond the state of the art. - Soundness of the proposed methodology, including the underlying concepts, models, assumptions, inter-disciplinary approaches, appropriate consideration of the gender dimension in	- Credibility of the pathways to achieve the expected outcomes and impacts specified in the work programme, and the likely scale and significance of the contributions from the project. - Suitability and quality of the measures to maximise expected outcomes and impacts, as set out in the dissemination and exploitation plan, including	- Quality and effectiveness of the work plan, assessment of risks, and appropriateness of the effort assigned to work packages, and the resources overall. - Capacity and role of each participant, and the extent to which the consortium as a whole brings together the necessary expertise.

	research *where relevant* and innovation content, and the quality of open science practices, including sharing and management of research outputs and engagement of citizens, civil society and end-users where appropriate.	communication activities. - Extent to which the members of the proposed consortium contribute to the expected level of in-kind contribution to operational activities to help reaching the target additional investments - SME Participation and opportunities to leverage project results.	

E. Documents

General Annex E of the General Annexes to the Horizon Europe Work Programme 2023-2025 shall apply *mutatis mutandis* to the SNS call 2025 covered by this Work Programme.

F. Procedures

General Annex F of the General Annexes to the Horizon Europe Work Programme 2023-2025 shall apply *mutatis mutandis* to the SNS call 2025 covered by this Work Programme with the following amendments related to the procedure to rank proposals:

i) Generic Case:

- When two **RIA** proposals are equally ranked and that it has not been possible to separate them using first the coverage criterion, second the excellence criterion, and third the generic Impact criterion (i.e., after step 2 of the procedure outlined in part F of the General Annex), the level of SME participation will be taken as the next criterion to sort out the ties and if still un-conclusive, the level of IKOP will be considered as appropriate. If still inconclusive, the procedure outlined in part F of the General Annex will be resumed from step 3 onwards.

- When two **IA** proposals are equally ranked and that it has not been possible to separate them using first the coverage criterion, second the impact criterion, and third the excellence criterion (i.e., after step 2 of the procedure outlined in part F of the General Annex), the level of SME participation will be taken as the next criterion to sort out the ties and if still un-conclusive, the level of IKOP will be considered as appropriate. If still inconclusive, the procedure outlined in part F of the General Annex will be resumed from step 3 onwards.

ii) Specific cases:

<u>Stream B</u>

Regarding the evaluation and ranking of proposals submitted under topics SNS-2025-STREAM-B-01-01: Advanced Architectures Systems and Technologies & SNS-2025-STREAM-B-01-02: Advanced IoT and Device Technologies the selection of proposals will take into account the need to cover all identified priorities (clearly identified under the Scope text; 5 priorities for B-01-01 and 3 priorities for B-01-02) under each of these topics.

To ensure a balanced portfolio within this cluster of activities on both above streams, grants will be awarded to proposals not only in order of ranking but at least also to one project that is the highest ranked within each of the Topic areas/priorities, provided that the proposals attain all thresholds (and subject to available budget). Proposals may want to address several of the proposed priorities in each Stream, but they should indicate clearly what is the centre of gravity of their proposal (i.e. the main covered priority).

<u>Stream D</u>

To ensure a balanced portfolio within Stream D and to guarantee that the approved projects will have different centre of gravity from the identified vertical priorities (i.e., Industry/Manufacturing, Media, Transportation/Logistics, Emergency and Safety Services and Health), grants will be awarded to proposals not only in order of ranking but at least also to one project that is the highest ranked within each of the above vertical priorities, provided that the proposals attain all thresholds (and subject to available budget). Only the centre of gravity vertical area will be considered in terms of topic coverage during the evaluation process.

G. Legal and financial set-up of the grant agreements

General Annex G of the General Annexes to the Horizon Europe Work Programme 2023-2025 shall apply *mutatis mutandis* to the SNS call 2025 covered by this Work Programme. In addition:

Participants of selected projects will be requested to cooperate in the SNS Programme for topics of common interests by signing a written agreement (called "collaboration agreement"[52]) referred in the specific provisions of the Model Grant Agreement (Annex 5 of the MGA[53]).

Further to Open science provisions set out in the General Annex G of the General Annexes to the Horizon Europe Work Programme 2023-2025, in all SNS topics under Stream B, AI/ML training data sets, which will be created and used in the context of the selected projects, have to be made available through a common repository that will be openly accessed and may be used by other SNS projects over the programme lifecycle.

H. Specific conditions for actions implementing pre-commercial procurement or procurement of innovative solutions

General Annex H of the General Annexes to the Horizon Europe Work Programme 2023-2025 is not applicable to the SNS call 2025 covered by this Work Programme.

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[52] Collaboration Agreement - SNS JU
[53] general-mga_horizon-euratom_en.pdf