ANNEX II TO DECISION No 03/2022 OF THE GOVERNING BOARD OF SMART NETWORKS AND SERVICES JOINT UNDERTAKING

ANNEX II to the 2023 SNS Work Programme 2023
SNS R&I Work Programme for 2023-2024

***Note**: This Annex II is attached to the comprehensive Work Programme 2023 of the Smart Networks and Services Joint Undertaking (SNS JU) and it details the planned SNS R&I Work programme for year 2023. This R&I WP for 2023 is published after approval of the SNS JU Governing Board and the related call 2023 is planned for opening in January 2023, with a deadline to submit proposals by the end of April 2023. However, in view of providing better, longer-term visibility and of exploiting complementarities, the SNS R&I WP 2023 has been conceived jointly with that of 2024. This document hence already provides visibility of the tentative topics of the SNS call 2024 such that applicants of call 2023 are aware of what is expected and can best plan, calibrate and focus their proposals. However, the SNS R&I topics and budget shortly presented in this document for 2024 are indicative and will be refined during the course of 2023, in view of reaching a stable version for approval by the SNS Joint Undertaking Governing Board during the second semester of 2023.*

Context and Objectives

The Research and Innovation Work Programme 2023-2024 (R&I WP2023-24) of the Smart Network and Services (SNS) Institutional Partnership supports the following Key Strategic Orientations (KSO), as outlined in the Horizon Europe (HE) Strategic Plan:

- **KSO A**, "Promoting an **open strategic autonomy** by leading the development of key digital, enabling and emerging technologies, sectors and value chains to accelerate and steer the digital and green transitions through human-centred technologies and innovations."
- **KSO C**, "Making Europe the first digitally led circular, **climate-neutral and sustainable economy** through the transformation of its mobility, energy, construction and production systems".

More specifically, the Horizon Europe SNS Partnership[1] targets a reinforced European leadership in the field of next generation network technologies (6G), connected devices and services, while accelerating European digital industry uptake and digitisation of economy and society. It aims at positioning Europe as a lead market and positively impact the citizen's quality of life, by supporting key Sustainable Development Goals (SDGs) while boosting the European data economy and contributing to ensure European sovereignty in these critical supply chains.

1 https://ec.europa.eu/info/files/european-partnership-smart-networks-and-services_en

Taking into account 6G international developments, the SNS Work Programme 2023-24 is still significantly focused on low TRL/medium to long-term R&I. Whilst 6G R&I and strategic programmes have been launched in many regions of the world with the objective of securing dominance on a number of technologies considered as strategic (notably in the USA, Japan, South Korea, China, India) there is still no unified 6G vision nor any declared commercial deployment initiative. ITU is currently working on a unified 6G vision that should be available during the course of 2023 as well as the related KPIs. Visions of 6G take up ecosystems are also subject to intense R&I at this stage. From a standardisation perspective, it is expected that 6G standardisation study work will start around 2025, which provides a significant window of opportunity to study in detail the multiple technologies that are called upon to realise future 6G systems. This Work Programme is hence designed to support the development of a top-class European know-how on these enabling technologies.

Within this broader context, the SNS R&I WP2023-24 addresses 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[2]. The 6G R&I focus in the WP2023-24 will complement R&I on enabling technologies / technical enablers with system-oriented R&I and dedicated prototyping and experimentation, complementing long-term R&I on disruptive concepts (e.g. academics driven). This covers several facets:

a) Industrial and business aspects

The 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 completely new services and applications, aligned with sustainability targets and a human-centric approach. This will eventually lead to 6G solutions, 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 current basis for this 6G vision is being developed in the context of the EC H2020 5G Infrastructure PPP / ICT-52 projects, including the Hexa-X Flagship project[3] and in related national 6G programmes. These developments are to be harmonized to form the common European Vision of 6G.
- The integration of future connectivity and service platforms into larger globally-applicable infrastructures, whilst preserving European competitiveness and sovereignty. The implementation of networks will increasingly take place across heterogeneous domains and the challenge will be to keep a strong EU influence whilst ensuring service delivery and control from an E2E perspective.
- 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.
- Bring new actors from, and beyond the verticals. Contributions from industry, RTO, academics 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 industry, in view of their potential impacts at downstream standardisation level.
- A stable experimental framework towards minimising R&I risk and validating core technologies.

2 https://5g-ppp.eu/wp-content/uploads/2021/06/WhitePaper-6G-Europe.pdf
3 https://5g-ppp.eu/ and https://hexa-x.eu/

- A unified consensus framework promoting a European approach towards 6G, facilitating international cooperation and placing Europe on par with other regions having started bold 6G initiatives.
- A strong European impact at future downstream 6G standardisation stages, including a Europe-wide consensus of 6G Key Performance Indicator (KPIs) that will frame future developments. By mid-2023 the consensus on KPIs will be outlined in key documents like the ITU IMT 2030 Vison document. Therefore, the SNS activities starting in WP2023-24 will focus on (1) the validation of the KPIs where a consensus has been established and (2) the further definition of the specific European KPIs that are not (yet) reflected in international consensus. 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 is included in this WP2023-24. 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 Partnership 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.

The work is also relevant in the context of several European policies[4], most notably:

- Europe's Digital Decade and Path to the Digital Decade Policy Programme[5].
- EU Cybersecurity Act[6] (Resilient Communication Privacy via Developing Proper Security Strategies).
- European Chips Act [7] (Microelectronic components).
- Artificial Intelligence (AI) [8, 9] .
- Data,Cloud and Edge Computing[10,11].
- High Performance Computing (HPC)[12].
- Internet of Things[13].

b) Sustainability aspects

The objective is to support key United Nations Sustainable Development Goals (SDGs)[14], with SNS aiming to contribute to:

---

[4] https://digital-strategy.ec.europa.eu/en/policies
[5] 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
[6] https://digital-strategy.ec.europa.eu/en/policies/cybersecurity-act
[7] https://digital-strategy.ec.europa.eu/en/library/european-chips-act-communication-regulation-joint-undertaking-and-recommendation
[8] https://digital-strategy.ec.europa.eu/en/policies/artificial-intelligence
[9] https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai
[10] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en
[11] https://digital-strategy.ec.europa.eu/en/policies/cloud-alliance#:~:text=Cloud%20and%20edge%20technologies%20are,on%20cloud%20and%20edge%20technologies
[12] https://eurohpc-ju.europa.eu/index_en
13 https://digital-strategy.ec.europa.eu/en/policies/iot-policy
14 http://www.un.org/sustainabledevelopment/sustainable-development-goals/

- **SDG 8**: Promote sustained, inclusive, and economic growth: achieve higher levels of economic productivity through diversification, technological upgrading, and innovation.
- **SDG 9**: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation, upgrade infrastructure and retrofit industries to make them sustainable with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes.
- **SDG 11**: Make cities and human settlements inclusive, safe, resilient, and sustainable.
- **SDG13**: Climate Action: Support smart low carbon lifestyles, monitoring emissions, and shaping demand in transport and energy, enabling resilient mission critical communications in extreme weather (vertical markets: transport, health, and public safety).

These SDGs are indicative and provided as an example to applicants. In addition, complementary societal issues, such as ethical issues in the context of privacy or Electric and Magnetic Fields (EMF) awareness and reduction, are targets of the SNS R&I WP.

Supporting Key Societal Value indicators (KVIs) such as safety, security, trustworthiness, inclusiveness, and sustainability are described in further detail below. Several factors form the basis for new research and innovation targets underpinning the evolution of 5G and the design of 6G networks. Some of them include full industry digitisation, supply chain resilience, and the need to address European and global societal challenges.

The 2030 Agenda for Sustainable Development and the related UN Sustainable Development Goals (SDGs)[15] aim to strengthen the social, economic and environmental dimensions of sustainable development. Beyond these objectives reinforced by the European Green Deal[16], which sets out a target for the EU to achieve climate neutrality by 2050, research on Smart Network and Services needs to address how 6G will be sustainable and how it will contribute to the sustainability of other sectors.

Sustainability is increasingly becoming a key target for the design of 6G, driving the choice of technologies and conception of the system to reach effective 6G solutions, with reduced environmental impact. While already partially addressed in the SNS WP2022 (mostly focusing on energy efficiency and associated carbon emissions), a systematic approach to sustainability (including other sustainability requirements) should continue and be considered globally, encompassing all aspects of sustainability, such as:

- Environmental sustainability, aimed at minimising the environmental impact of technologies (e.g. reduced carbon footprint, energy consumption and use of available resources, …).
- Societal sustainability, enabling people to engage, evolve, live healthy lives and ensuring their long-term social well-being by providing value to society.
- Economic sustainability, aiming at supporting long-term economic growth.

Sustainability and a related indicator framework should be considered from an end-to-end (E2E) perspective, including all the elements in the networks (from service platforms to end devices).

A sustainable 6G infrastructure is a key objective of the SNS Partnership, but 6G should also become an enabler of sustainability, benefitting other sectors and verticals by enabling optimised or new services and applications aimed at reducing the environmental footprint, or contributing to meeting UN SDGs. This approach is reinforced in SNS R&I WP2023-24.

[15] https://www.un.org/development/desa/dspd/2030agenda-sdgs.html
[16] COM(2019) 640 final

c) Joint activities between KDT and SNS

The European Chips Act, adopted by the Commission early 2022 aims to enhance Europe's competitiveness and resilience in microelectronics technologies and applications, and help achieve both the digital and green transition. One of its objectives is to help Europe reach leadership in chips for digital connectivity infrastructures. Europe has a leading position in the global connectivity infrastructure market, while at the same time has strong dependencies on chipset vendors from outside the European Union.

In the above context and with the aim of reinforcing European strength in microelectronics and connectivity, the KDT and SNS JUs are both launching focus topics as joint and complementary activities in their respective Work Programmes with both constituencies encouraged to participate in the relevant projects funded.

In particular, the planned SNS strand "SNS-2024-STREAM-C-01-01: SNS Microelectronics Lighthouse" aims to develop an experimental platform where solutions from the micro-electronics domain developed either in the context of Phase 1 SNS WP, or Horizon Cluster 4, or the KDT JU will be validated in terms of performance and applicability for 6G networks. Therefore, solutions developed in projects funded under the current KDT focus topic could find their way into the afore-mentioned SNS topic. The SNS Joint Undertaking Work Programme for 2023-2024 also includes strand "SNS-2023-STREAM-B-01-05: Microelectronics-based Solutions for 6G Networks". To decide whether interested stakeholders would like to apply for the current KDT focus topic or the SNS strand, consortia should consider the following table comparing the respective scope of the two strands.

	Targeted KDT Focused Topic[17]	SNS-2023-STREAM-B-01-05 (RIA)
Expected TRL at end of project	5 to 6 (ready to be integrated in a system-level prototype)	2 to 4
Frequency ranges	100 GHz and above (sub-THz and THz range)	From sub-6GHz up to THz
Transmission chain coverage	Radio front-end (from baseband interface to antenna)	From baseband and mixed-signal processing to RF and Antenna system

d) 2023-2024 Work Programme Structure

The scope of the SNS WP2023-24 considers the full value chain. The NetworldEurope Strategic Research and Innovation Agenda (SRIA) 2022 is the foundation for the definition of the R&I technical themes of the SNS WP and Work Plan. The SRIA is developed by R&I stakeholders under coordination from the NetworldEurope ETP, including contributions from the 6G Smart Networks and Services Industry Association (6G-IA), the wider cloud (NESSI), IoT and edge (AIOTI), and Satellite Communications (SATCOM) communities. The SRIA 2022 underpins the core technological topics to be addressed by the SNS Partnership as well as the higher-level objectives and the implementation of the 6G roadmap.

The proposed R&I WP2023-24 includes the following three complementary streams[18]:

- **Stream B:** it covers research for revolutionary technology advancements, in preparation for 6G and revolutionary advancements of IoT, devices and software. This Stream targets low to medium TRL in WP2023-24, with the objective of delivering innovative solutions towards real-life networks in a long-term period of time.

[17] KDT 2023 Work Programme Focus Area is planned for publication on 7 February 2023.
[18] Stream A of the Phase 1 SNS WP (2021-2022) is not supported in this WP which comes too late to further influence 5G Advanced standardization.

- **Stream C:** it focuses on SNS Enablers and Proof of Concepts (PoCs) used to further develop, federate and consolidate experimental infrastructure(s), in support of the various phases of the SNS Partnership. Stream C developments will focus on energy-efficient technologies for 6G and will be open to integrate microelectronics developments coming from other programmes.
- **Stream D:** it targets large-scale 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. During the second SNS phase, Stream D projects are expected to mostly rely on SNS Phase 1 technologies and especially the infrastructures to be developed from Stream C projects. The goal is to gradually incorporate innovative 6G functionalities. From the societal point of view, stream D will highlight sustainability evaluations across verticals, validating exploitation of 6G across different vertical sectors.

The updated SNS roadmap (Figure 1) illustrates the phases of the streams.

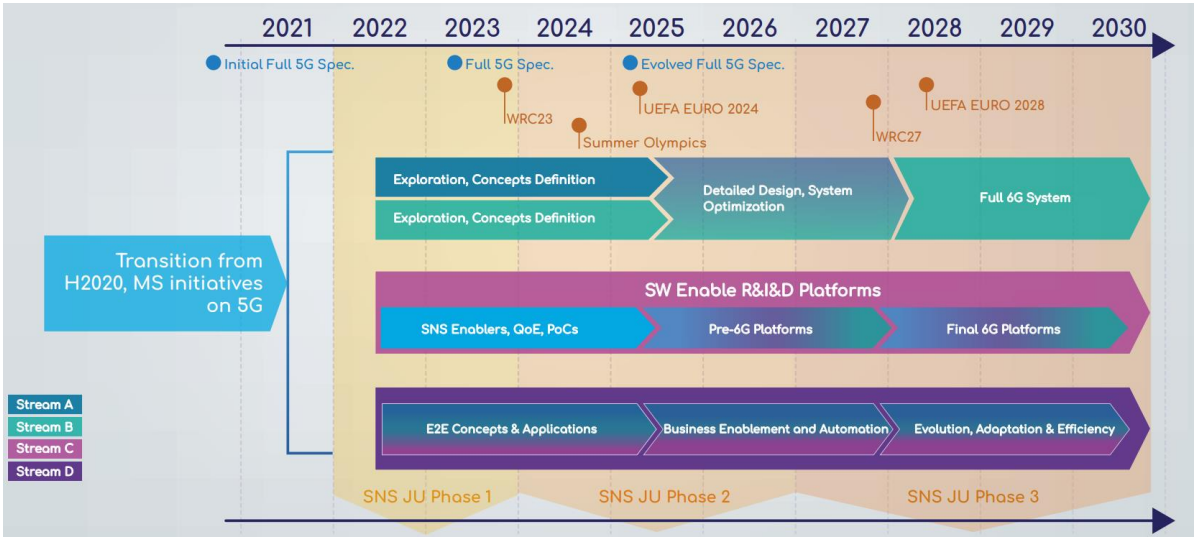

Figure 1: SNS Roadmap

Figure 2 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 2 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 the subsequent phase Stream D Vertical Pilot projects.
- 6G solutions and potential PoCs, to be developed in Stream A and B projects during Phase 1, are expected to contribute to the Experimental Infrastructure projects (Stream C) and Vertical Pilot projects (Stream D) of subsequent SNS JU phases. Note that Stream A will not be present in Phases 2 and 3, as 5G advanced solutions will be completed by then.
- 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 subsequent SNS JU phases. 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.

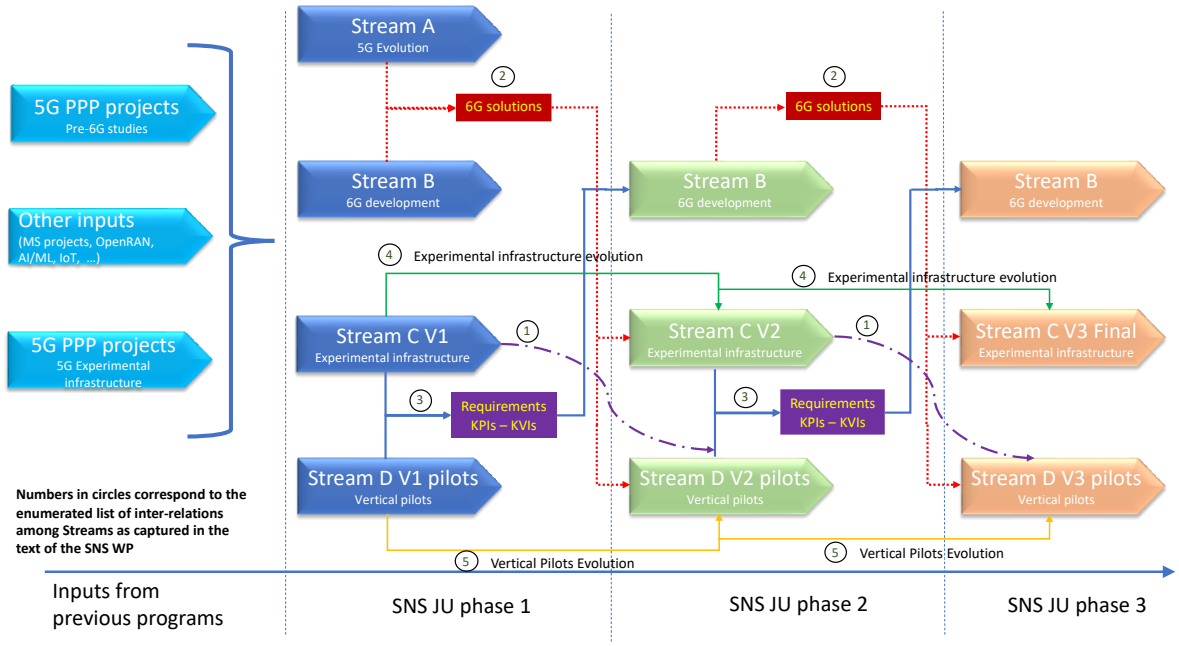

Figure 2: Interlinking of Streams into Phases

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 European industrial competitiveness. Applicants are invited to get familiar with the European background work on KPIs and KVIs[19, 20]

By the time of the implementation of this second Work Programme, multiple initiatives launched in several Member States or Associated countries will already be operational providing important results. Where applicable, applicants are encouraged to use national developments, to maximise the efficiency of public investments in Europe, which allow for synergies among different funding instruments and thus, create positive multiplier effects.

It is also important to note that selected projects of the various Streams will cooperate in the SNS Programme for issues of common interests, using the contractual collaboration clause of the Model Grant Agreement (MGA) in Articles 3 and 7.

Notes to applicants

For the purpose of the implementation of this R&I Work Programme, provisions of the General Annexes to Horizon Europe[21] 2023-2024 apply with some exceptions that are specific to the SNS WP. These exceptions are detailed in the Appendix 1 to this Work Programme in addition to the Specific Conditions outlined for the definition of each funded topic under this Work Programme.

[19] https://5g-ppp.eu/wp-content/uploads/2022/05/What-societal-values-will-6G-address-White-Paper-v1.0-final.pdf
[20] https://hexa-x.eu/wp-content/uploads/2022/04/Hexa-X_D1.2_Edited.pdf and https://hexa-x.eu/wp-content/uploads/2022/03/Hexa-X_D1.3.pdf
[21] https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/horizon-europe-work-programmes_en

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

Specific Challenges and Objectives

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.
- **Disruptive high value applications** support, with performance requirements beyond those of current 5G capabilities (scalability and new KPIs), especially for highly immersive and "digital twinning" applications.
- **Green transition** contribution with significantly lower energy needs for high-rate/performance connectivity and capabilities to decrease energy needs of use cases.
- **SDGs** support and in particular connectivity and service availability (coverage), affordability (cost) and accessibility for a large number of use cases of high public value.
- **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.

The Stream targets low TRL (2-5) technology advancement and addresses an integrated ecosystem with IoT, devices hardware and software-based solutions in unified terrestrial and non-terrestrial (3D) networks. 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:

- Technologies supporting the validation and feasibility of the globally accepted set of KVI's and KPI's framing ongoing 6G developments and contributing to global interoperability. Such globally accepted KVIs and KPIs are expected to emerge by mid-2023.
- Availability of key technologies and open architectures with high potential for 6G standardisation, either in the early 6G standardisation phase expected to start around 2025, or for subsequent longer-term releases.
- Progress towards an optimised architecture, beyond the 5G Service Based Architecture (SBA), encompassing device, edge, network, data centers and enabling a massive upscaling of requirements originating from immersive environment applications, whilst preserving past 5G investments of communication service providers for non-greenfield scenarios. Such driving requirements include at least traffic volumes, speed, latency, positioning, local storage and processing.
- Availability of a zero-touch open end-to-end resource management system, beyond current "local" industry/standards developments (RIC, NWDAF) with drastic OPEX reduction and innovation support, including the ability to perform sustainability-related decisions (e.g. power cost of operation).
- E2E Trustworthy and energy-efficient device, network, and service infrastructures, to deliver critical services in a sustainable manner. It also includes enablers and open

APIs to significantly reduce energy/carbon footprint of use cases making use of the 6G connectivity platform (e.g., automotive, factories, healthcare, etc.).

- 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.
- Managed spectrum and dynamic spectrum sharing across multiple frequency bands, opening new application scenarios including combination with sensing, optimising spectrum efficiency, lowering energy consumption, and addressing EMF aspects.
- Foster European capabilities in key technologies and notably AI/ML, software and security enablers, advanced signal processing and microelectronics, paving the way towards advanced fully automated systems across all network layers. It includes the availability of open data sets originating from the projects.
- A longer-term re-examination of fundamental system features and functionalities, including service interfaces, namespaces, communication primitives, location and time synchronisation, and energy monitoring.
- Stimulation of international cooperation and international consensus on critical technologies.

Note 1: Microelectronic components for future 6G platforms, notably for IoT devices and virtualised "disaggregated" network implementations will be considered with objectives to: i) support a collaborative framework with Key Digital Technologies Joint Undertaking (KDT JU), fostering 6G component developments, ii) ensure participation of the EU microelectronics industry in upcoming standardisation phases to leverage IP.

Note 2: Cloud and edge cloud technologies and software implementation of network/device are 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.

Note 3: Sustainability is an important element of this second Work Programme.

Note 4: Stream B activities are expected to demonstrate strong capabilities towards valorisation of results in relevant 6G standardisation bodies.

Stream B covers the following activities:

- 6G Research and Innovation projects (disruptive - low TRL) in the technical domains of (1) System Architecture, (2) Wireless and Signal processing, (3) Communication Infrastructure Technologies and Devices, (4) Secure Service development and Smart Security and (5) Microelectronics-based Solutions for 6G Networks (Call 2023).
- 6G Research and Innovation projects targeting 6G standardisation and proof of concepts (6G SNS Phase 2 R&I) in the technical domains of (1) System Architecture, (2) Wireless and Signal processing, (3) Communication Infrastructure Technologies and Devices and (4) Secure Service development and Smart Security (Call 2024).
- 6G Lighthouse project on 6G Sustainability (Call 2024).
- International Cooperation projects on 6G Research and Innovation with the USA (Call 2023), Japan and South Korea (Call 2024).

HORIZON-JU-SNS-2023-STREAM-B-01-01: System Architecture

Specific conditions (see complementary conditions in Appendix 1 to this WP)	
Expected EU contribution per project	The Commission estimates an EU contribution of around EUR 4 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 20 million
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 2-4 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

Technology components for:

- Intelligent connectivity across a huge number of heterogeneous domains, resources with unlimited number of application requirements and conflict resolution mechanisms for incompatible requirements.
- Overall system functional architectures to cater for the expected extreme 6G use cases and their requirements moving beyond the Service Based Architecture (SBA)[22] limitations of 5G. This includes an AI native architecture, providing the mechanisms that will allow optimal exploitation of intelligent mechanisms at control, management and service deployment levels.
- Solutions for inter-computing beyond the inter-networking capabilities of the Internet, making the execution of services possible across multiple heterogeneous but seamlessly inter-working domains, each possibly applying different policies (e.g., in terms of security, routing, access to resources, etc.), routing mechanisms, access mode to application services, etc. including capabilities to support 3D networks.
- Internet-like architecture(s) supporting much higher dynamics and versatility for its topology and service instantiation while significantly lowering energy consumption.
- Architecture and technologies enabling the connectivity and service infrastructure to be programmable with a single, unifying, and open controllability framework, spanning all resources a tenant is authorised to control, including resources from currently separate and heterogeneous domains, such as enterprise and telecom networks, virtual and physical, data centres and routers, satellites, and terrestrial nodes.
- Architectures providing build-in capabilities/mechanisms that will allow the establishment of innovative business models.
- Solutions with the potential to be considered for the early architectural standardisation work, for example under 3GPP SA TSG.

Scope

The scope covers the realisation of a unified and open communication and computing architecture beyond the current 5G SBA capabilities. Such architecture will enable seamless

[22] Service Based Architecture. See 3GPP TS 23.501, TS 23.502, TS 23.503

operations across a multiplicity of heterogeneous domains, infrastructures, services, business, and application heterogeneous domains, paving the way towards massive digitisation. The architecture should be agnostic to transmission technology, but should be able to enable further optimisations for cellular, optical and NTN communications, as well as for fog, edge and data centre computing environments. It offers a consistent/reliable programmable environment enabling "tailor made" implementation of various tenants' requirements whilst providing secure and reliable scalability towards an unlimited number of requirements. The scope also covers new paradigms and solutions that are looking promising for the further reengineering of network architectures. Applicants should define the domain boundaries of their planned solutions and how they intend to maximise take up prospects in a fully heterogeneous domain. The focus of this Strand is on several complementary issues mentioned below and applicants may select one or more of those:

- AI powered edge cloud continuum. Support of a fully distributed and collaborative AI approach across the various RAN, edge and core CIC (Compute Inter-Connection) domains. An AI plane and associated functions (going beyond traditional Network Data Analytics) will optimise control and user plane operations in scenarios requiring diverse set of contradictory requirements (for example deterministic latencies and energy efficiency), including the optimisation of the optimal operational integration of heterogeneous (e.g., legacy) networks with the 6G Service Based Architecture. Also, in scope are specific AI/ML mechanisms suitable for: i) the transient nature of resources in the IoT domain (links, devices) e.g. constrains of compute power, energy, and time; ii) guaranteed convergence of meaningful outcomes in swarm-alike environments, i.e., facing the availability of many yet individually weak agents; iii) interfaces, data models, and orchestration strategies able to explore federated learning architectures and platforms close to the edge, to enhance data protection, improve inference reliability, and increase autonomy of end clusters. Energy efficient AI is in scope.
- Technologies for efficient Network and Service Resource Management in dynamic multi-tenant environments. This covers control and management aspects such as runtime service scheduling, conflict avoidance, conflict resolution, and the relationships between functions being executed in the deep edge (terminal or IoT device), the operator edge, and the core. These technologies include cross-domains solutions, on the fly SLA, architectures, as well as associated protocols, and algorithms, for dynamic, runtime assignment of resources to tasks, such that the executing system handles each task successfully under that task's specific constraints while explicitly accounting for the resources used by the solution per se and its novel, added constraints. In scope are protocols and algorithms for user-to-system interface, i.e., exposing available resources and capabilities to the user applications and getting requirements from user applications explicitly or implicitly. It must achieve overall improvements in relevant KPIs (e.g., successful service throughput on an unchanged system; or resource usage such as energy, capacity, etc.) while avoiding (or resolving) potential conflicts brought by the potential uncoordinated usage of highly volatile resources, where the executing system strives to handle tasks successfully under that task's specific constraints in such multi-tenant environments. Also in scope are the extreme challenges for IoT-oriented architectures, with challenging design given the particularities of its domain-specific resources (constrained battery-driven devices: security constraints, capability constraints, price limits), typical scaling and geographical spread expectations, and challenges for NTN environments.
- Energy efficiency enablers. In scope are protocols, algorithms, models, and policies to increase energy efficiency of the network. This covers metrics to capture energy consumption of resources in highly distributed, virtualised environments, including instrumentation to query and collect energy consumption metrics; models for target costing in terms of energy requirement per task; models able to specify the relationship

of energy consumption with service and system KPIs and KVIs; policy definition and implementations for energy efficiency management in function of system requirements. Adherence to, and evolution over, ongoing standardisation efforts will be welcomed. The target is to provide the mechanisms to eventually realise the best energy aware dynamic implementation of network and service functions as a function of the use-case requirements.

- Pervasive Resilient Autonomic Resource Control in Virtualised Systems: In CIC networks, the multi-tenancy and dynamicity of the resource pool endangers the essence of the network existence – it is necessary to build a reliable and stable system with a (potentially very large) set of unreliable components. In scope are highly scalable, distributed, self-organising control and management protocols to provide in-band connectivity between all resources. These routing protocols should work across a variety of different topologies (sparse, dense, changing), should support mobility and multi-homing of nodes and avoid creating traffic concentrations. These protocols have to be used in zero-configuration and zero-touch approaches, essential so that no configuration errors can break the connectivity, and that failures be auto-corrected.
- Integrated and dependable sensing & actuation networks. The increasing penetration of the digital and physical world, in a new cyber reality, brings particular challenges for the reliability and trust of such systems, highlighting the need for new architecture concepts. The scope covers Integrating sensing and communication with the aim of making such functionalities available to users or operators of networks, e.g., how to expose any possible trade-offs, how to properly express access rights, etc., in view of addressing essential aspects for societal privacy and trust concerns, associating actions to frameworks promoting reliability and security. It presents extra complexity every time there is a complementary actuation when a network triggers actions in the real world. This includes issues such as exactly-once semantics, dependable execution of such actions, checking whether actions have indeed taken place by a corresponding sensing action and where issues like AAA and cost/billing for such activities needs to be addressed. The incorporation of these features in sematic oriented communications is also in scope.
- Digital network twinning applied in 6G: This includes the dynamic virtual representation of critical components and systems, including the simulation and modelling tools for large-scale real-time environments; derivation of network models (digital twins) from traffic analysis; and digital twin models as a core for network planning, management and control.
- New Communication Paradigms with enhanced intelligence. The work addresses innovative protocols in view of overcoming known Internet limitations as originating from new scenarios and vertical requirements (ultra-low latency, extreme mobility, ultra-high data rates, integration of end-terminals, controlled security, space applications). It considers systems where edge, access and cloud are increasingly undistinguishable (i.e., used homogeneously by the service layer), and diverse techniques can be considered, such as beyond IP networking or semantic/knowledge-based communications, in such fast-changing environment. Research should address functional improvements of the basic communication concepts, including transport mechanisms with improved packet delivery and/or energy efficiency able to cope with increased dynamics in network topologies. These communication paradigms should be able to flexibly operate in local/global architectures and provide primitives to perform the integration of new localized environments in an intelligent ICT system. Energy/efficiency improvements should be demonstrated in the research.

HORIZON-JU-SNS-2023-STREAM-B-01-02: Wireless Communication Technologies and Signal Processing

Specific conditions (see complementary conditions in Appendix 1 to this WP)	
Expected EU contribution per project	The Commission estimates an EU contribution of around EUR 4 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	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 2-4 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The target outcomes include:

- Wireless technologies and systems capable to meet expected 6G radio capabilities such as Tbps data throughput, sub-ms latency, extremely high reliability, massive mMTC, extreme energy and spectrum efficiency, very high security, and cm-level accuracy localisation, across a range of frequency bands mostly focusing on up to millimetre wave solutions.
- Innovative RAN (Radio Access Network) solutions supporting multi-band operation, wireless caching, and integrated communication sensing techniques.
- Technologies enabling support of new higher efficiency mobile communication approaches, such as cell free networking, massive MIMO or Large Intelligent Surfaces with capability to drastically reduce energy consumption and to control EMF exposure levels.
- Applicability and validation of innovative AI/ML based architectures to control adaptive L1/L2 functions with optimised feedback control and operations.
- Solutions enabling entire new wireless application domains and based on integration of wireless communications and sensing.
- Solutions to optimise sustainability issues, including energy efficiency visual acceptability and minimisation of urban visual pollution.

Scope

Note: The focus of this Strand is on techniques to improve the performance of radio links and systems for 6G communications. Physical layer of THz communications has been extensively covered by projects selected in the first SNS call and is subsequently not expected to be a strong focus for this topic. Moreover, the scope covers the design of 6G RAN systems. The focus of this Strand is on several complementary issues mentioned below and applicants may select one or more of those:

- New physical layer technologies up to millimeter wave. This includes both new channel modulation and coding schemes, new adaptive waveform designs, and advanced link-layer random and multiple access strategies, this includes non-orthogonal approaches (e.g., NOMA, RSMA). Support to innovative channel coding approaches towards “error

free" channel transmission up to millimeter wave for technologies, including signal shaping loss removal. It should solve current bottlenecks in implementation issues such as computational complexity, algorithm parallelisation, energy efficiency, etc. whilst supporting (potentially cumulatively, depending on the scenario) extremely high throughput (hundreds of Gigabits per second); low latency; high reliability; and extreme low latency. It should also support scalability of future Machine Type Communication with minimum protocol overhead and energy consumption. Solutions should be compatible with increasingly massive MIMO-implementations and contribute to the future modulation and coding schemes, possibly mixing data-driven and model-driven approaches, as required for 6G, retaining reliable, energy-efficient characteristics.

- Extreme exploitation of MIMO technologies up to millimeter wave range. This includes ultra-massive MIMO and distributed and cell-free massive MIMO (including intelligent reflecting surfaces). The work should encompass distributed implementations of (potentially cell-free) massive MIMO encompassing a very large number of antennas, with centralized and distributed algorithms for coordinated transmission/reception, involving large numbers of users and considering implementable MIMO predistortion for wideband massive arrays.
- Human-friendly Radio systems: Support innovative antenna and physical layer technology for higher acceptability of radio infrastructures by citizens. It covers new antennas and new antenna systems, including antennas arrays (e.g. massive MIMO systems), that need to visually blend seamlessly in the urban landscape through use of new designs, in the context of an increased density of base stations and more complex antennas to support higher frequency ranges. It also covers antenna systems for EMF control and awareness to minimise human exposure.
- Spectrum Re-farming and Reutilisation: Support future high bandwidth demand and versatile spectrum usage requirements by multiplicity of applications through optimised spectrum management, sharing and dynamic application aware allocation. It covers spectrum reutilisation between RAT's, including NTN access, and addresses new THz spectrum. Novel approaches with use of AI/ML technology for real-time spectrum efficiency is in scope. It also covers specific sharing scenarios for unlicensed spectrum use, and fundamental work on these challenges for new Terahertz bands will also be needed.
- Seamless integration of multiple frequency bands across a unified energy, EMF, and spectrum efficient framework including unlicensed bands and potential optical access. Open and disaggregated solutions may be considered also in scope.
- Machine learning empowered physical layer evolutions: The ambition is to develop an overall enhanced RAN adaptive and intelligent, with complexity increasing at the Radio Unit (RU) end, moving towards semantic-oriented communications. The scope aims to cover the overall physical layer, and the associated radio building blocks and communication protocols, with reduced complexity in the neural network modelling of multidimensional nonlinear effects.
- Optimal usage of wireless edge caching: The ambition is in developing advanced methods and protocols, including concepts able to improve radio link KPIs, such as energy efficiency, spectral efficiency, capacity, throughput, reliability, quality of experience (QoE), or investigate promising over-the-air computing paradigms.
- Novel techniques for integrated sensing and communication: the goal is for radical communication work to be complemented by work in the field of location and sensing capabilities for devices. The work requires radical new distributed and cooperative sensing, sensing aided communications, and multi-band sensing technology, as well as integrated waveform design.

HORIZON-JU-SNS-2023-STREAM-B-01-03: Communication Infrastructure Technologies and Devices

Specific conditions (see complementary conditions in Appendix 1 to this WP)	
Expected EU contribution per project	The Commission estimates an EU contribution of around EUR 4 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 Actions
Technology Readiness Level	Activities are expected to achieve TRL 2-4 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The target outcomes address:

- Development of new access networks, focused on different set of devices, expanding the reach of 6G and reducing its environmental impact. An important outcome relates to solutions making it possible to expand network coverage to 3D coverage scenarios, with troposphere networks allowing to overcome the limitations of today's 2D networks.
- Advances in long distance communications, able to provide solutions for diverse sets of high mobility, large area, scenarios, such as UAVs.
- Availability of solutions enabling the "network of network" approach with capability to support ultra-short distance connectivity scenarios, based on nano things networking, and applicability to specific domains like health care or automotive.
- Ultra-low energy solutions for devices, including battery free device capabilities.
- Ultra-low energy and ultra-high capacity solutions for access or end to end connectivity based on optical technologies and their integration within a wireless-optical connectivity continuum.

Scope

The scope covers the design of new systems and components for 6G networks. The focus of this Strand is on several complementary issues mentioned below and applicants may select one or more of these issues:

- Troposphere Networking: The work addresses Tropospheric Networking as the new network serving all the "things" between the ground and ~20 km altitude and focus on control and communication services for the drone, urban air mobility (future urban transportation systems that move people by air), balloon, aircraft, etc. Application scenarios covering both airplanes and UAVs should be defined and both data and control requirements identified. Solutions that rely on novel device to device (D2D), mesh, and cellular solutions for different types of mobility nodes may be considered, including approaches for unified RAN cellular (or cell free) coverage for both air and ground coverage, including high altitude dynamic beam steering, and efficient network level mobility management. This topic has a transformative potential for the infrastructure strand in general and is considered particularly challenging if supported only by terrestrial technologies.

- Integration of Optical and Wireless Technologies of advanced light related technologies such as LEDs (light-emitting diodes), lasers, outdoor point-to-point devices (FSO — Free Space Optics), point-to-multipoint commercial applications (Li-Fi — Light Fidelity) or between devices (OCC – Optical Camera Communication) and Fiber Wireless (Fi-Wi), for the design of novel communication schemes, system architectures and protocols, in order to fully integrate these technologies in the communication infrastructure. Hybrid RF/FSO communications and sensing techniques to underpin selected verticals and applications are in scope.
- Nano-Things Networking: The work addresses technologies to extend connectivity towards micro things, towards the realisation of nano-communications extending the reach of smart control to the level of small/tiny things, including molecules and cells. Materials with software-defined electromagnetic behaviour enable applications, paving the way for programmable wireless environments. The focus is on nanomaterials and nano-network architecture components (nodes, controllers, gateways) opening new prospects of usage of nano-scale things. At the PHY Layer, graphene antennas enable nano-communication within the 0.1 - 10 THz spectral window, which promises unprecedented communication data rates despite the nano-scale. At the MAC Layer, pivotal protocols could target Body Area Network (BAN) applications notably for health and self-monitoring and adapting industrial materials. This research topic should lead to potential transformative impact across the communication ecosystem.
- Development of low-energy communication solutions: This includes system solutions that consider zero-energy, battery-free and/or disposable devices. The solutions should be able to present system and device integrated solutions relying on the principles of minimising the environmental impact of the expected billions of sensors, including concepts as RF and environmental energy harvesting, simultaneous power transfer and communications systems, eco-friendly and degradable devices (and the optimisation of the 6G system required to fully exploit these devices notwithstanding their expected limitations, providing a joint network/device design paradigm).
- Packet optical technologies for 6G radio networks: Solutions for optical networks to support 6G cellular networks are being pursued, targeting high-speed, fast reconfigurable, optical enabled radio systems considering integrated solutions for backhaul and fronthaul communication. The focus should be on technologies which will be effective in operational conditions in highly dynamic and customizable environments, guaranteeing its programmability while minimising unnecessary opto-electronics transitions. The research scope covers devices for RAN, including optical processing as an enabling technology, programmable devices, wavelength selectable optical switches, tuneable lasers and filters, as well as an efficient utilisation of packet and optical (spectrum and spatial) resources. It also includes the integration of the aforementioned solutions in an intelligent software management system, able to simplify and optimize the network (e.g. by avoiding IP routing, and low power consumption reconfiguration). It may also include novel switching paradigms.

HORIZON-JU-SNS-2023-STREAM-B-01-04: Reliable Services and Smart Security

Specific conditions (see complementary conditions in Appendix 1 to this WP)	
Expected EU contribution per project	The Commission estimates an EU contribution of around EUR 4 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 16 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 2-4 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The target outcomes qualify the needed level of reliability, trust and resilience that applies to a critical infrastructure like 6G based on a globally connected continuum of heterogeneous environments supported by the convergence of networks and IT systems to enable new future digital services.

- Availability of technologies supporting the necessary levels of trustworthiness, resilience, openness, transparency, and dependability expected under the EU regulations (such as GDPR and Cyber Security Act, including associated provisions including new certification processes) across a complete continuum incorporating the human-cyber-physical system including connectivity-service provision, supporting complex human centric multimodal communications, including entangled devices.
- Availability of technologies ensuring secure, privacy preserving and trustworthy services in the context of a programmable platform accessed by multi-stakeholders and tenants including vertical industries as users, for increasingly fleeting and dynamic scenarios.
- Secure host-neutral infrastructure where multiple infrastructure providers are involved in the deployment, hosting and orchestration of the network service, especially in the context of stringent requirements for the communications.
- Identification of the life cycle of smart services security and trust requirements including development, provision, operation, maintenance and of their business impact on the stakeholders' ecosystem.
- AI technology applied to security and service deployment in several ways: i) correct application of AI to enhance security and service deployment in 6G; ii) consideration of potential security threats using AI.
- Operational security: End-to-End, system wide Security policies composition and management among multiple stakeholders based on trusted and eventually certified services, eventually providing technology solutions in the context of regulatory initiatives like the cybersecurity toolbox.
- New services and security technologies that will fulfil 6G needs and EU policies in this area.

Note: The perimeters of the heterogeneous domains considered addressed by the proposals should be clearly identified as well as the expected impact towards the adoption of solutions, especially when domains outside of EU jurisdiction are considered.

Scope

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

- Service deployment for complex services: In-network / edge computing has evolved into a standard component of network architecture. However, it is geared mostly to "conventional" workloads: services running on behalf of individual users, with ordinary resource needs (e.g., web servers or network functions). The scope extends these capabilities towards truly flexible, resilient and versatile in-network computing, including: i) a broader range of deployable artefacts (e.g., Web Assemblies); ii) workloads that pertain to an entire user population (shared services like games, or even services for huge populations like joint video streaming for many watchers); iii) workloads with new characteristics (like bursty in-network training for ML models; iv) End-to-End Security Policies composition in distributed dynamic scenarios; v) data authenticity and trusted digital interactions in dynamically composed service environments. Challenges here pertain to the entire lifecycle from development, deployment, operation and decommitment, for a diversity of dynamic user populations, including explicit support for in-network computation with advanced patterns (e.g., ML training workloads, workloads coming from user populations not just individual users, additional types of deployment units).

- Cooperative holistic E2E security for 6G architectures. Developing security architectures for providing E2E security guarantees across the heterogeneity and dynamicity of technologies envisaged in 6G is a major challenge. This topic should be able to address multi-layer, multi-provider protocols and interfaces for E2E adaptive security delivery (inter-orchestrator agent-based distributed convergence) ensuring multi-tenancy (e.g., verticals) remediation strategies with regard to business objectives (although vertical specifics); multi-layers/stakeholders authorities (including compute/network/security service providers); and include cooperative and adaptative (AI-based) attack detection (attacks known/zero days-anomalies). The solutions should be able to handle a diversity of 6G scenarios (cell, cell-less, 3D/NTN, private, public environments), and should cover realistic E2E security for Cyber Physical scenarios, with termination points of the system being sensing. Ultimately the work can delve on the challenges of roots for an EU wide, private/public CTI (Cyber Threat Intelligence) dedicated to 6G systems.

- Zero-touch integrated security deployment: The dynamics of the 6G system require autonomic and multi-agent approaches to security deployment, similar to the challenges of service deployment, in an environment with multiple control loops. Techniques should be able to address adaptive protection, detection and response, and reasoning techniques based on digital twins or AI are promising for candidates to consider.

- Exploitation of (distributed) AI/ML for 6G Infrastructures, targeting net-zero scenarios: This topic covers security and service deployment scenarios. The objective is the development of techniques, protocols of novel architectures for the integration of AI/ML in scenarios to multiple applications in terms of security and service processes, including aspects as securing physical layers (e.g. anti-jamming), provide adaptive response to incidents, define service and security function placement (protection and detection), and for the intrinsic resilience of the AI process (e.g. data poisoning in control/management), improving AI security. It can address societal concerns such as potential biased usage of AI and includes both the threats directly applicable to user data traffic, and their control and management. Another major concern inside this

challenge is to promote the utilisation of renewable energy resources (deployed and distributed all over the network) for the learning process, able to provide an efficient greenness-accuracy trade-off, preserve privacy, and scale to large networks.

- Developments on service technologies for secure time-sensitive and computation intensive applications. The challenges posed by virtualised environments require a new set of technologies to support stringent requirements. The topic aims to develop techniques able to: i) assure time guarantees for containers or similar virtualisation technologies; ii) time aware orchestration frameworks; iii) provide secure isolation techniques for dynamic instantiations; iv) abstraction mechanisms for the network compute fabric to support function delegation in low power scenarios.
- Physical layer security: Physical layer security technologies, including ML based techniques to combat the increased number of potential threats (e.g., rogue terminal/network identification, eavesdropping detection) and cyberattacks to secure both users and networks, and considering the new attack surfaces brought in by new hardware and software architectures (e.g., massive MIMO, RIS).
- Human Centric methods that give the control to the user to guarantee privacy and confidentiality, for both service development and service execution. It addresses service and business enablement with security attributes exposure and security awareness through security SLA, auditable per stakeholders and users. Methods for quantification of security to make the users aware of the systems and services used and associated risks is in scope, including certification proposals to raise user awareness.

HORIZON-JU-SNS-2023-STREAM-B-01-05: Microelectronics-based Solutions for 6G Networks

Specific conditions (see complementary conditions in Appendix 1 to this WP)	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 5.0 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
Technology Readiness Level	Activities are expected to achieve TRL 2-4 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Note: This topic is part of the target joint activities with the KDT Joint Undertaking and applicants are invited to explain how such synergy may be achieved through their planned activities.

Expected Outcome

- Increased capabilities of European microelectronics industry to provide solutions for communication networks and devices (beyond the today 4% of global markets), in line with the findings of the CoreNect CSA[23].
- Available solutions for devices at various levels of the device data processing chain, from baseband and mixed-signal processing to RF and Antenna system and considering new spectrum that may be needed for 6G.
- Availability of validated hardware solutions that may be used, especially from a physical layer radio perspective, in the context of the 6G standardisation with strong partnership between the microelectronics and communication industrial actors.
- Availability of open solutions that may support further innovation at any level, from the end devices to core 6G network components.
- Availability of solutions that will offer significant energy reduction for 6G communication systems.
- Availability of detailed technology and subsystem characterisation that can be further leveraged from a full development perspective under the KDT JU, in view of materialising the 6G-IA and AENEAS MoU agreement[24].

Scope

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

- Improved and more energy- and cost- efficient radio hardware for 6G RAN solutions for any ranges from below 6 GHz up to THz supported by implementations requiring integration of heterogeneous technologies, very wideband transceivers (>5GHz at Baseband), low impairments in general, low EVM support of moderate to high spectral efficiency that are potentially capable of joint communication and sensing, broadband same frequency full-duplex RF frontends for massive MIMO, reconfigurable surfaces, multi-band or multi-octave transceivers, high linearity, low phase noise, low impairments in general, also possibly addressing NTN environments requirements for low/medium earth orbit.
- Beamforming and multi-user technologies for any ranges from below 6 GHz up to THz including indicatively topics like Wideband beamforming, True time delay, Solutions for beam squint, Run-time calibration, Hybrid beamforming and MIMO, THz antenna systems (e.g., lens arrays and intelligent reflecting surfaces) that overcome the high path loss of THz bands that can be integrated by 6G networks to meet the new demanding KPIs.
- Antenna and packaging technologies and materials for 6G RAN solutions for any ranges from below 6 GHz up to THz including topics like On-chip antennas, Lens-integrated antennas, Planar and conformal antenna arrays, Integrated waveguides, Low loss distribution networks, Beamforming and MIMO, Meta-materials and meta-surfaces, human friendly radio systems (handle increased density, higher frequency ranges, control EMF).

Topics beyond the above scope may also be considered as long as they are complementary, relevant for the development of 6G networks and clear synergy with KDT topics is established in the proposals.

[23] CoreNect Roadmap: see https://www.corenect.eu/roadmap
[24] https://5g-ppp.eu/aeneas-and-6g-ia-join-forces-to-build-synergies-for-european-leadership-in-next-generation-telecommunications/

Applicants are encouraged to validate the aforementioned technologies in a system context, i.e. including power-efficient and ultra-fast ADC and DAC converters suitable for the aforementioned frequency bands, and an optimized use of advanced/heterogeneous computing platforms for baseband processing (e.g. based on general-purpose processors, GPUs, FPGAs, ASICs and combinations thereof), with the purpose of providing ultra-low latency, energy efficiency and optimised performance in the radio access network and the edge-to-cloud continuum.

HORIZON-JU-SNS-2023-STREAM-B-01-06: EU-US 6G R&I Cooperation

Specific conditions (see complementary conditions in Appendix 1 to this WP)	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.0 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 3 million.
Type of Action	Research and Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL 2-5 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

- EU-US research cooperation on selected critical 6G technologies and architectures exploring AI, paving the way towards global validation, adoption and standardisation of intelligent approaches, notably in the context of key 6G KPIs.
- A widely accepted framework for meaningful evaluation of proposed AI/ML-powered solutions for 6G networks.
- Technology validation in platforms where appropriate.
- Joint progress towards AI large scale applicability in 6G networks and standardisation opportunities supported by availability of common data sets and learning sequences provided in an open manner.

Scope

The scope of the target project covers:

- EU US R&I cooperation on key next generation wireless including 6G technologies and architectures powered by Artificial Intelligence. AI may be considered at various levels from a future target 6G systems, from lower layer radio aspects (e.g. reconfigurable waveform, Reflective Intelligent Surface processing, etc.) to higher layers targeting intelligent function placement, network self-configuration, security and resilience, or AI based support of user applications.
- Support to a reference framework for AI usage for the telecommunications domain in relation to 6G, including methodologies, reference use cases, data acquisition and generation, repositories, curated training and evaluation data, as well as the technologies and functionalities needed to use it as a benchmarking platform for future AI/ML solutions for 6G networks. The framework may address a wide range of usage

contexts, covering both different applications areas of AI (e.g. physical layer, networking, security), and different business ecosystems (e.g. typical end to end network operators, open networks, cloud and infrastructure operators, federated and virtual operators). Typical 6G metrics should be able to be evaluated, including data rate, latency, density, energy efficiency, flexibility and performance, and/or security. Methods of accreditation of usage/compliance may also be considered to validate techniques.

- The scope includes availability of data sets, contributing to 6G Human Centricity and Societal acceptance and in compliance with the rules of data legislation, both existing and new ones created by the project, that may be used by researchers to validate AI approaches and inference rules applied to the selected network/device challenge. Contribution to the framework and data access is expected to add value, notably for improvement and expansion of data sets, tools and algorithms for efficient new AI/ML solutions. Generation and exchange of data across EU-US stakeholders is in scope where possible and appropriate. Proposals on validation of AI techniques over experimental platforms, additionally providing the associated datasets, are in scope.

Applicants are invited to explain how the EU-US cooperation will be implemented, i.e., the target US initiative to collaborate with and the approach of cooperation to be deployed with US stakeholders. The retained project is expected to work with relevant US funded project(s). Only organisations established in the EU and associated countries will be eligible for EU funding.

HORIZON-JU-SNS-2024-STREAM-B-01-01: System Architecture - Standardisation and Follow-up/PoCs

Specific conditions	
Expected EU contribution per project	The Commission 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 16 million
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome and Scope

These projects are follow-up projects on the topics identified in SNS-2022-STREAM-B-01-01. The target is to further progress the work in these areas focusing on achieving a significant impact in 6G standardisation activities (e.g., 6G Broadcasting, frictionless inter-domain resource management, Native Integration of AI for telecommunications and AI as a service, 6G system architecture with simplification and sustainability, robustness and security, Network exposure to vertical application developer (e.g., Interfaces for industrial standards as OPC-UA), Integration of IEEE tech with 6G (WiFi7-WiFi8)), and/or the development of PoCs on promising enabling technologies that will demonstrate Europe's leading role in this area. The scope includes, where relevant, harmonization/coordination with Member States' or Associated Countries 6G initiatives Any produced PoCs should be implemented in a way that

their integration in SNS WP2025-26 Stream C and/or Stream D project will be possible (e.g., open-source solutions, appropriate documentation, support after the completion of the project…).

The detailed definition of this R&I SNS Call 2024 activity is subject to modifications and will be completed by Q3 2023 and annexed to the SNS Work Programme 2024.

HORIZON-JU-SNS-2024-STREAM-B-01-02: Wireless Communication Technologies and Signal Processing – Standardisation and Follow-up/PoCs

Specific conditions	
Expected EU contribution per project	The Commission 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 16 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome and Scope

These projects are follow-up projects on the topics identified in SNS-2022-STREAM-B-01-02. The target is to further progress the work in these areas focusing on achieving a significant impact in 6G standardisation activities (e.g., technologies for sustainable and efficient radio systems, Massive and ultra-massive MIMO including Reconfigurable Intelligent Surfaces and cell-free massive MIMO) and/or the development of PoCs on promising enabling technologies that will demonstrate Europe's leading role in this area. The scope includes, where relevant, harmonization/coordination with Member States' or Associated countries 6G initiatives. Any produced PoCs should be implemented in a way that their integration in SNS WP2025-26 Stream C and/or Stream D project will be possible (e.g., open-source solutions, appropriate documentation, support after the completion of the project…).

The detailed definition of this R&I SNS Call 2024 activity is subject to modifications and will be completed by Q3 2023 and annexed to the SNS Work Programme 2024.

HORIZON-JU-SNS-2024-STREAM-B-01-03: Communication Infrastructure Technologies and Devices – Standardisation and Follow-up/PoCs

Specific conditions	
Expected EU contribution per project	The Commission 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 16 million.

Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome and Scope

These projects are follow-up projects on the topics identified in SNS-2022-STREAM-B-01-03. The target is to further progress the work in these areas focusing on achieving a significant impact in 6G standardisation activities (e.g., Flexible Capacity Scaling, Ultra-high Energy Efficiency, NTN infrastructures: Integrated NTN service provision, Integration of Optical and Wireless Technologies, etc.) and/or the development of PoCs on promising enabling technologies that will demonstrate Europe's leading role in this area. The scope includes, where relevant, harmonization/coordination with Member States' or Associated countries 6G initiatives. Any produced PoCs should be implemented in a way that their integration in SNS WP2025-26 Stream C and/or Stream D project will be possible (e.g. open-source solutions, appropriate documentation, support after the completion of the project…).

The detailed definition of this R&I SNS Call 2024 activity is subject to modifications and will be completed by Q3 2023 and annexed to the SNS Work Programme 2024.

HORIZON-JU-SNS-2024-STREAM-B-01-04: Reliable Services and Smart Security– Standardisation and Follow-up/PoCs

Specific conditions	
Expected EU contribution per project	The Commission 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 16 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 3-5 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome and Scope

These projects are follow-up projects on the topics identified in SNS-2022-STREAM-B-01-04. The target is to further progress the work in these areas focusing on achieving a significant impact in 6G standardisation activities (e.g., Integration of operational security including third-party Security as a Service, 6G penetration testing, Ethical Hacking and security level benchmarking, 6G cyber range platforms, Towards a 6G Toolbox with global standard perspective, Dedicated 6G CTI etc.) and/or the development of PoCs on promising enabling technologies that will demonstrate Europe's leading role in this area. The scope includes, where relevant, harmonization/coordination with Member States' or Associated countries 6G initiatives. Any produced PoCs should be implemented in a way that their integration in SNS

WP2025-26 Stream C and/or Stream D project will be possible (e.g. open-source solutions, appropriate documentation, support after the completion of the project etc.).

The detailed definition of this R&I SNS Call 2024 activity is subject to modifications and will be completed by Q3 2023 and annexed to the SNS Work Programme 2024.

HORIZON-JU-SNS-2024-STREAM-B-01-05: International Collaboration – EU-JP

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.0 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 3.0 million.
Type of Action	Research and Innovation Action
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome and Scope

This SNS International Cooperation activity target Japan in line with the objective outlined under the EU-JP Digital Partnership. It builds on the interactions developed between 6G-IA and the key associations and stakeholders in other regions/countries, notably the JP B5G Promotion Consortium.

The cooperation with Japan tentatively targets intelligent AI native platforms in direct connection to the related research and innovation work in Japan, as reported in the B5G Promotion Consortium. This domain will also allow to leverage the Open RAN/virtualisation experience of Japan, towards interoperability testing of architectural approaches in EU and JP. This action is targeting standardisation impact.

The key following targeted outcomes are considered:

- Joint identification of standardisation requirements and contribution to standardisation bodies and fora, supporting global views on open standards and interoperability, with particular focus on 3GPP and WRC developments.
- Significant contributions to the testing and evaluation methodologies of 6G access technologies under 3GPP.
- Proof of concept for an interoperability/architecture framework which demonstrates a possible way forward for the needed definition of the interoperability specifications, that future 6G products have to achieve, and towards related standardisation activities for existing and new interfaces.

The detailed definition of this R&I SNS Call 2024 activity is subject to modifications and will be completed by Q3 2023 and annexed to the SNS Work Programme 2024.

HORIZON-JU-SNS-2024-STREAM-B-01-06: International Collaboration – EU-SK

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 3.0 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 3.0 million.
Type of Action	Research and Innovation Action
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome and Scope

This SNS International Cooperation activity targets South Korea. It builds on the interactions developed between 6G-IA and the key associations and stakeholders and notably the SK B5G Forum. The targeted action in this Strand will focus on EU-SK R&I developments. The cooperation with South Korea will tentatively focus on RAN, considering SK terminals and devices industry capabilities. The action will focus on the integrated device-network approach demonstrating a number of 6G functional properties. This action is targeting standardisation impact.

The following targeted outcomes are considered:

- Joint identification of standardisation requirements and contribution to standardisation bodies and fora, supporting global views on open standards and interoperability, with particular focus on 3GPP and WRC developments.
- Significant contributions to the testing and evaluation methodologies of 6G access technologies under 3GPP.
- Proof of concept for an interoperability/architecture framework which demonstrates a possible way forward for the needed definition of the interoperability specifications, that future 6G products have to achieve, and towards related standardisation activities for existing and new interfaces.

The detailed definition of this R&I SNS Call 2024 activity is subject to modifications and will be completed by Q3 2023 and annexed to the SNS Work Programme 2024.

HORIZON-JU-SNS-2024-STREAM-B-01-07: Sustainability

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 10 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 10 million.
Type of Action	Research and Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL 2-5 by the end of the project – see General Annex B.

Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

- Consolidation of the work started in first SNS projects on sustainability (use cases, KPIs/KVIs, dedicated technologies) and integration of its outcomes as well as those of other projects into an end-to-end sustainable set of tools and solutions.
- Technologies and architectures enabling to manage a systemic approach to sustainability (going beyond energy efficiency and security - related to social sustainability) from an end-to-end perspective,
- Methodologies, guidelines and protocols as well as a related indicator framework supporting an End-to-End (E2E) perspective, including all the elements in the networks (from service platforms up to devices).
- "6G for sustainability" use cases developed jointly with verticals demonstrating how 6G contributes to the various aspects of sustainability.
- The technical solutions will be integrated into the end-to-end sustainable platform.
- A European approach towards sustainability as integral part of the 6G standardisation, furthering the definition of KVI's of various projects.

Scope

The work covers both "Sustainable 6G" and "6G for sustainability". It includes identification and developments of the technology/architectures needed to make 6G solutions (end-to-end) sustainable. "Sustainable 6G" and "6G for sustainability" should be considered with equal importance. Sustainability will be considered through three dimensions: (i) environmental sustainability, targeting the minimisation of environmental impact; (ii) societal sustainability, aiming at providing value to people and society thanks to new use cases powered by 6G, and (iii) economic sustainability, where 6G will be an enabler for business value. This threefold approach will drive the design and integration of technical solutions into an end-end sustainable set of tools and solutions. Building on the work conducted in previous and on-going SNS projects, the system and architecture outcomes will be integrated into this end-to end platform. The use cases and related KPIs/KVIs as well as business models will be jointly developed with different stakeholders, such as the 6G-IA, existing 5G-PPP and SNS projects, verticals industries and associations, representatives of the public sector, supporting associations.

This work will include one dedicated End-to-End Sustainability Lighthouse project complementing and furthering the work developed by the 6G Holistic project (SNS Phase 1 Call HORIZON-JU-SNS-2022-STREAM-B-01-05) on the E2E design of a sustainable 6G, but also on 6G for sustainability, strengthening the work with verticals to develop 6G as an enabler for sustainability of other economic sectors. The Lighthouse project will interact with other SNS projects by (1) integrating the results and key finding from end-to-end perspectives and (2) providing recommendations and guidelines. The Lighthouse project will contribute to define the EU approach to sustainable 6G and develop a toolbox (standards, protocols, reference architectures…) available for reuse. The Lighthouse project is also targeting to validate the different architectures, technologies, protocols, methodologies in different contexts and identify how and E2E 6G ecosystem will comply with sustainability requirements that go beyond energy efficiency. The developed indicator framework could also be tested for its applicability. The final result will drive 6G deployment.

The detailed definition of this R&I SNS Call 2024 activity is subject to modifications and will be completed by Q3 2023 and annexed to the SNS Work Programme 2024.

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

Specific Challenges and Objectives

The challenge is to make pan European platforms available that can be used to test and experiment candidate 6G technologies with capabilities to:

- Validate and reduce the introduction risk of candidate 6G technologies, components and architectures at system or sub-system level, paving the way towards their adoption at standardisation and at market level.
- Show the applicability of such technologies to efficiently support advanced application and use cases not supported by current 5G and 5G Advanced systems.
- Harmonise the usage of multiple test platforms existing across Europe, to build a pan European, cross platform framework.
- Extend this pan European platform to other relevant test platforms outside Europe, namely with existing platforms e.g. in the USA.

This topic will continue and enhance the work on experimental platforms of Phase 1 with gradual implementation of 6G functionalities. A relevant aspect here, is the development of pan-EU interconnections of relevant Platforms and Nodes in EU (e.g., SNS Phase 1 platforms, or 5G PPP platforms), and synergies between the EC projects platforms and platforms developed at National level. The Stream offers opportunities to include additional platforms not considered in Phase 1 and to integrate KDT Projects outcomes into SNS Platforms. It must be noted that although Stream C intends to gradually develop experimental platform(s) over the different SNS phases, projects implemented under Phase 1 and submitting a follow up in this second phase should not be considered as having any priority over new proposals.

The main objectives of this topic are hence:

- To continue the development of EU wide experimentation platforms that can incorporate various candidate 6G technologies for their further validation.
- To extend the capabilities of such an experimentation platform e towards a federated approach, able to support advanced pilot “6G” use cases as targeted under Stream D during the different SNS implementation phases.

Similarly to Phase 1 projects, related objectives include:

a) Reusability and evolvability of the experimental platforms over the lifetime of the SNS programme: Platforms or specific components can be further extended to ensure a continuous integration of the most promising 6G technologies. The developed platforms should be able to be incorporated as infrastructure for use by future Stream D projects.

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

c) Directionality and optimisation of previous and related investments in Europe: 6G experimental platforms piggybacking on previous investments in Europe (e.g., SNS proof-of-concepts or platforms, or from the 5G Infrastructure PPP Work Programme where relevant) 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.

d) Disruption friendly: Experimental facilities should be capable of hosting possible upcoming unplanned 6G disruption and hence guarantee their future-proofness.

e) End-to-end: The target experimental facility should be capable of demonstrating E2E service capabilities and include a full value chain including IoT devices, connectivity, and service provision.

Stream C is continued and reinforced in SNS WP2023-24, targeting (1) the development the first in a series pan-European platforms which are of strategic importance at EU/EC level (2) the federation and development of pan-EU interconnections between existing SNS platforms and nodes in EU (potentially including platforms developed by Member States' or Associated countries initiatives) and potentially establishing international cooperation with other related actions being developed in the US (if possible); (3) the integration of KDT Projects outcomes into selected SNS Platforms.

HORIZON-JU-SNS-2023-STREAM-C-01-01: Complementary SNS experimental Pan-EU federated Infrastructure (RIA)

Specific conditions (see complementary conditions in Appendix 1 to this WP)	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 14 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 14 million.
Type of Action	Research and Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 4-6 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The main outcome will be the availability of an evolvable large scale experimental infrastructure for the duration of the SNS programme, which complements the infrastructure under development by the Phase 1 project portfolio, with capabilities for federation of existing experimental platforms and that makes it possible to:

- Validate a representative end-to-end 6G architecture including, disaggregated and open architectures, secure end-to-end service provisioning with slicing capabilities and ability to accommodate technological and architectural disruptions of 6G. Validation covers architectures beyond the 5G SBA, notably the AI native architecture with end-to-end AI based management capabilities, as well as cloud continuum including operational multi-access edge computing.
- Work towards the availability of European federated open platforms for advanced 6G wireless systems testing and integration within Europe with capability extension towards other national testbeds (e.g. US). Support where possible the development of synergies with 6G platforms developed in EU Member States (MSs) or Associated countries at national level in the context of 6G national R&I programmes.
- Assess 6G KPIs in the context of interoperability and cross region experiments of 6G networks, services and devices.
- Demonstrate the operational performance of key 6G candidate technologies, components, and architectures operating across various frequency bands. This also

includes demo capabilities at basic building block level (e.g. m-MIMO, waveform…) or at system level (e.g. cell free network). To that extent, technologies as identified notably under Stream B Strands may be considered as a baseline. Support to impactful contribution to standards is also in scope.

- Demonstrate technological/operational feasibility of "better than 5G / 5G Advanced" KPIs, related indicatively to capacity, ubiquity, speed, latency, reliability, density of users, location accuracy, energy efficiency, service creation time, network management CAPEX/OPEX. It will include capability to incorporate emerging 6G specific KPIs and the capability to address key KVIs as developed by previous 5G PPP and SNS projects.
- Integrate full value chain experiments covering IoT/devices, connectivity, and service delivery.
- Support innovative use cases and applications for the large-scale trials and pilots with vertical actors to be carried out in Stream D projects, 5G Advanced capabilities and to support showcasing events.
- Support the demonstration of the technological operational feasibility of key societal requirements and objectives such as energy reduction at both platform and use case levels, EMF impact and acceptability, sustainability, security, trust and resilience. Other key societal indicators include coverage, accessibility and affordability of the technology.
- Validate management functions such as zero-touch and fully automated operation with a high level of trust with security measures and processes including and covering the full technological chain, from device to service provision and execution of trustworthy and exchange of actionable information.
- Support integration of key 6G related KDT developments, though integration of wireless/processing advanced components within the platform.

Scope

The target 6G experimental infrastructures provides the capability to support the demonstration and operational validation of the most ambitious use-case scenarios as deriving from the European 6G vision. It includes the capability to interconnect the physical world, the digital world and the human world based on a connectivity and service platform with performance capabilities beyond current 5G and 5G Advanced platforms and IoT application scenarios. The target experimental platform hence includes validation capabilities at every relevant layer of the IoT-connectivity-service provision value chain, covering typically innovative components and microelectronic capabilities, fixed/multi radio access (including NTN), backhaul, core network, and service technologies and architectures, covering disaggregated scenarios like Open architectures blurring RAN and core. End-to-end virtualisation and network slicing are key components to support multi-tenant environments, integration of private/non-public and public networks and 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.

The experimental platforms will offer the capability to support disaggregated architectures enabling software and hardware implementations eventually able to support AI native 6G services including end-to-end service provisioning with advanced slicing capabilities**.** It is also futureproof by enabling to incorporate novel or disruptive technological approaches, and notably new spectrum and associated technologies, "AI-based service architectures", communication and computing integration, AI-based zero-touch management and intelligence connectivity, integration of communication and sensing capabilities as typical, though not limitative capabilities. The target experimental environment is also capable for supporting and

demonstrating key non-functional properties and in particular end-to-end security, security provision in the context of further integration into a larger environment (hyperscalers), energy efficiency at both platform and use case levels, and EMF-awareness.

The scope includes an open, disaggregated, versatile, and unified end-to-end platform operating over multiple interconnected B5G/6G sites in multiple European countries and following where possible open architectures at cloud implementation level thus, delivering the highest degrees of performance, flexibility and functionality for supporting testing and validation of innovative B5G/6G use cases such as holographic, XR/VR/telepresence, digital twins, cooperative robots, AI-as-a-service and haptic communications.

The demonstration/operational capabilities of the target platform are to be assessed against a set of emerging KPIs and KVIs as typically defined by the 6G international community and on-going initiatives. Proposals should be flexible enough to accommodate new relevant KPIs as they become available from the wider 6G community and from potential use cases.

To provide the required openness to host vertical use case pilots it is desirable that the platforms 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 infra and service interfaces will have to be defined in view of interoperability with complementary platforms.

It is important to note that the stakeholders will commit that the result will be easily replicated in the same or additional locations/countries if this platform will be selected for large scale trials as part of Stream D.

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

One important target is that the experimental platform is expected to manage the development of federation capabilities to enable interoperation with existing platforms (e.g., SNS Phase 1 platforms, or platforms developed in national initiatives) with identification and development of needed tools, technologies and architectures, including Open API’s. The objective is to potentially enable demonstration capabilities by federating multiple platforms, for advanced use cases for future phases of Stream D. Provision of capabilities to extend such a federation to non-EU based technologies and platforms would be an asset, notably in the context of EU-US cooperation under WP 2023, and also to prepare for future calls.

Evaluation of core 6G technologies and architectures in the context of specific 6G use cases may be considered but is not mandatory.

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.

HORIZON-JU-SNS-2024-STREAM-C-01-01: SNS Microelectronics Lighthouse

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 10 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 10 million.
Type of Action	Research and Innovation Action
Technology Readiness Level	Activities are expected to achieve TRL up to 6 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

- Extending the results and momentum of the EC 5G Infrastructure PPP ICT-42 COREnect CSA project, which has defined a roadmap for Microelectronic components for telecom systems and to reinforce synergies with the KDT JU. Availability of an experimentation platform where innovative European solutions on targeted areas will be deployed and evaluated.
- Extension of the work initiated to be developed by the HORIZON-CL4-2022-DIGITAL-EMERGING-01-30 project (European Enabling technologies for Beyond 5G/6G RAN disaggregated architectures (RIA)) but also in other areas like mm Wave, sub-THz and THz communications, wireless transceivers, ultra-low power wireless, new antennas etc mentioned in SNS-2023-STREAM-B-01-5.
- Solutions for the Radio Access part of the network, considering available solutions for future network implementation especially in the context of a future 6G disaggregated RAN and of the 6G convergence/virtualisation of data processing across the complete delivery chain, from RAN to data centre. Valorisation of KDT outcomes in the context of the THz focused actions.

Scope

The scope of this project is to develop an experimental platform where solutions from the microelectronics domain developed either in the context of Phase 1 SNS WP, or Horizon Cluster 4, or the KDT JU will be used to validate their performance and applicability for 6G networks. The experimental platform is expected to focus on the Radio Access Network (potentially including solutions covering a wide spectrum e.g., up to THz) providing solutions in key areas identified by the COREnect CSA project. Advanced baseband capabilities as needed in virtualised platforms from the device or network side, taking open approaches and RISC-V technologies as targets and supporting SoC's implementations are expected to be investigated and solutions to be produced. AI Edge modules, integration of multiple technologies for JCAS, Flexible hardware platforms supporting virtualisation and programmability in a fully distributed edge environment, including hardware accelerators are also in scope.

The scope also considers extension of the KDT WP 2023 focused action on THz Communication and covers the integration of the THz communications technology into a complete THz communication chain and demonstrator, in view of validating the technology in an end to end radio system context, focusing on the two main THz communications applications: Integrated Access Backhaul (IAB) with high capacity provided to a myriad of small/nano cells; direct short range high capacity access as needed in specific industrial environments.

This does not however exclude the potential inclusion of microelectronics solutions in the transport domain or unified solutions with NTNs and support of the IoT-connectivity-service provision value chain. The key purpose of this project is to serve as a bridge between the SNS JU and the KDT JU, offering on the one hand new requirements to the microelectronics domain while on the other hand providing validation results of the tested solutions to KDT JU

so that these can be considered in the subsequent phases of the KDT. The purpose of the project is to create an active cooperation link between the two communities and serve as a catalyst for further related activities for the EU private and public sectors.

Where relevant, the lighthouse project will also engage collaboration with on-going projects in Member States' or Associated countries 6G initiatives including similar activities.

The detailed definition of this R&I SNS Call 2024 activity is subject to modifications and will be completed by Q3 2023 and annexed to the SNS Work Programme 2024.

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

Specific Challenges and Objectives

The challenge is to prepare at an early stage of the SNS programme competitive solutions with the potential for future adoption and market take-up of European SNS technologies and systems at a global level. The 5G experience has shown that it takes several years to prepare the adoption of 5G systems by key vertical players. The objective is thus to validate 5G Advanced and 6G technologies in a user context early in the process, to maximise downstream take up. This Stream targets:

- The validation of SNS KVIs and KPIs in the context of very advanced digital use cases implemented through Large-Scale Trials and Pilots (LST&P).
- The identification of use case specific KVIs and KPIs and how they may be matched by SNS platform KVIs and KPIs.
- 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 Stream C).
- Accessibility and openness: The required targeted adaptations of the Stream C infrastructures/platforms as required to support specific Stream D use cases should be available in further phases of the SNS by any consortium, which requires using modular implementation methodology, potentially open-source solutions with well-defined and clearly documented technological and business interfaces.

The Stream contributes to the creation of ecosystems with verticals identifying real business pain points and how these can be addressed by advanced technological solutions. Stream D will pivot towards increased evaluation of sustainability impact of ICT technologies in different ecosystems.

A related target is to leverage relevant 5G Advanced / 6G solutions available from European initiatives, also at the national level (where possible), in this field. Stream D projects are thus expected to benefit from already identified 6G enablers (i.e., AI/ML, cybersecurity, HPC, advanced IoT solutions) to ensure a high relevance in the SNS context. When implemented over Stream C infrastructures or PoC's, it may be needed that platform enhancements are needed for the specific target use case. In this case, these Stream C enhancements are expected to follow the same requirements as expressed for experimental platforms, in particular openness, reusability, and accessibility.

The activity should also target visible and high-level exposure of European capabilities and leadership in 5G Advanced / 6G technologies through support of large showcasing events.

A target of Stream D is to address (1) Verticals projects with no or low coverage in Phase 1 projects, (2) KPIs oriented projects, targeting to validate significant network KPIs improvements towards 6G systems (e.g., throughput, latency, reliability, spectral efficiency,

etc.) in order to serve advanced and demanding use-cases and applications to be further developed by Verticals sectors and (3) Sustainability-focused projects, with evaluation of sustainability aspects of ICT in vertical sectors. Use-cases that drive the 6G perspective, e.g., use-cases based on highly immersive digital representation of the physical world and of massive twinning, whilst leveraging the EU community active in this domain, are expected to be addressed in this phase. Where relevant, the use-cases to be addressed by the verticals are invited to consider the dimension on climate change adaptation.

Concerning security, due to the potential use of 5G and 6G infrastructures for safety-related services and their relevance to public security and public order, it is essential to ensure the highest level of cybersecurity in this sector. According to Article 170 of the Council Regulation establishing the Smart Networks and Services Joint Undertaking, actions involving network elements deployed for large-scale experimentation or piloting may have to follow security scrutiny assessments.

Proposals are expected to demonstrate EU added value, with particular attention to the role of suppliers in the cyber-security of the network elements deployed for large-scale experimentation or piloting, as well as in the development of a sustainable supply chain from an EU perspective.

In addition to such an assessment in the context of the potential impact of the proposed project, any remaining security concerns in proposals need to be addressed. In the context of 5G networks, the role of suppliers has been identified in the EU coordinated risk assessment and the EU Toolbox on 5G cybersecurity[25] as of particular relevance for cyber-security.

Cyber-security risks identified in the Toolbox are less likely if the active components and related services are provided by entities established in Member States and not controlled from third countries[26]. Moreover, the toolbox foresees strategic measures to foster a sustainable 5G supply and value chain in order to avoid long-term dependency. In this context it identifies the specific strategic measures necessary for the Commission to ensure that participation in Union funding programmes in relevant technology domains will be conditional on compliance with security requirements, by making full use of - and further implementing - security conditions.

In the context of stream D, the following security issues are particularly relevant among others:

1) A test infrastructure is connected to an operational network or is using resources from an operational network. This could lead to a cyber-security risk in scope of the 5G cyber-security toolbox.

2) Large scale test infrastructure is standalone, i.e. not connected to an operational network, but utilises close-to-commercial equipment. In this case, connectivity of this operational equipment (or of equipment from vertical companies trialling specific use cases) to equipment from entities established in or controlled from third countries may lead to exchange of data related to project results potentially causing security risks or undermining a sustainable supply chain from an EU perspective.

Therefore, to ensure the highest level of cybersecurity, as well as a sustainable supply and value chain in the area of 5G, beyond 5G and 6G, it is of utmost importance to ensure that sensitive cybersecurity related information and project results are protected and not, other than in exceptional circumstances, exposed, either for cooperation purposes during the project or after the project, to entities not established in Member States or controlled from third

[25] https://digital-strategy.ec.europa.eu/en/library/eu-toolbox-5g-security

[26] According to the EU coordinated risk assessment of 5G networks, the risk profiles of individual suppliers can be assessed based on several factors. These factors include the likelihood of interference from a third country. This is one of the key factors specified in paragraph 2.37 of the EU coordinated assessment.

countries. This should in particular apply to suppliers of equipment as well as suppliers of relevant services.

Such security considerations are relevant for the assessment of the potential impact and, if necessary, to be considered in a security scrutiny assessment, where project results considered as security-sensitive information need to be exchanged among project partners. Specific security issues in that context are to be identified in the security section of part A of the proposal whilst mitigation measures should be outlined in the Annexed form to the proposal.

Implementation modalities are specified in the additional call conditions under Appendix 1.

HORIZON-JU-SNS-2023-STREAM-D-01-01: SNS Large Scale Trials and Pilots (LST&Ps) with Verticals – Focused Topic

Specific conditions (see complementary conditions in Appendix 1 to this WP)	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 10-14 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 27 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 5-7 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 70% for profit organizations
Legal and financial set-up of the Grant Agreements	Financial Support to Third Parties (FSTP) is allowed up to 20% of the proposal budget. See details in appendix 1 section 1.9.

Expected Outcome

- Contribution to the further refinement of sustainable seamless E2E 5G Advanced and 6G test infrastructures with fine-tuned capability to integrate vertical use cases specific performance/KPI requirements, as applicable also across public and non-public networks and services.
- Validated infrastructure core technologies and architectures in the context of vertical large-scale pilot use-case implementations and relevant deployment scenarios.
- Validated core technologies and architectures across the value chain (IoT, connectivity, services) for differentiated performance requirements originating from concurrent implementation of use-cases and specialized services for verticals.
- Viable business models for innovative digital use cases tested and validated across a multiplicity of industrial sectors, including demonstration of required device/network/service resource control from the vertical industry business model perspective.
- Support to impactful contributions towards standardisation bodies notably for 6G use cases and technologies.

- European 5G Advanced and 6G know-how showcasing. Visible events widely open to the public are particularly relevant.
- Stimulate large industrial stakeholders, SMEs and the European Academic and Research community to engage in experimental activities in a timely fashion, aimed to validate technological trends for 6G networks.
- Repository of requirements from verticals and of "lessons learned" to prepare for subsequent phases of the SNS programme. It should include records and evaluation of 6G KPIs considering 5G Evolution and the aforementioned requirements and validating them with services linked to specific vertical sectors and related KVIs.
- 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.
- Collection of new requirements that are needed in subsequent phases for the key 6G technological building blocks, notably those identified in Stream B. Those requirements may stem from e.g., the emergence of new application domains (Internet of Senses, holographic type communications…), the native support of AI/ML by future networks, the introduction of zero-touch solutions, high resilience/availability needs.

Scope

The target 5G Advanced / 6G systems validation work through large scale trials is expected to cover at least the following domains:

Application level: this topic addresses verticals of strategic importance given their economic or societal impact, and the level of public/private R&D investments to date in the EU.

- Use Case Priority 1 for this topic is on connected and automated mobility (CAM) vertical and intelligent terrestrial transportation.
- Use Case Priority 2 include the following verticals (to be considered independently or in combination): Health, Smart Cities, Farming, or Education.

Note: *To ensure a balanced portfolio covering both aforementioned Priorities 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 two Priorities (Priority 1 on CAM and Priority 2 on complementary use cases in the specific vertical sectors Health, Smart Cities, Farming or Education (to be considered independently or in combination)) provided that the proposals attain all thresholds.*

In that context, applicants are invited to clearly specify in their proposal under which Priority they are applying.

Validation should demonstrate clear benefits of the considered 5G advanced/pre-6G technologies and architectures in terms of scalability, security, and performance improvements in line with medium to long-term socio-economic scenarios.

- Management level: the validation should demonstrate the efficiency of the end-to-end resource management technologies and architectures, through two aspects: i) significant improvement of new resource usage efficiency, towards zero-touch management and effective OPEX; ii) additional capabilities offered to vertical users through open interfaces enabling more efficient implementation of use cases (e.g., AI for networks vs. network for AI at the application level).
- Societal level: the validation should demonstrate significant improvement of key parameters like energy consumption (both for the SNS platform and the vertical use cases), safety (incl. EMF exposure), coverage and access, cost and affordability, trustworthiness, security and privacy being part of the priority SDGs to demonstrate in a "user context", i.e. sufficiently representative of a target operational context.

The Large-Scale 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 with a landscape unified management able to support the emergence of a European offer and capability.

Projects would involve SMEs, scaleups and start-ups. SMEs, scaleups and start-ups are expected to play a key role in this process with new market-driven applications that can build value on the 5G 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 capabilities are to be assessed against a set of well-defined KVIs and KPIs. The developing set of KPIs in the international context will be taken as a basis, also those of previous projects, notably for KVIs. Proposals should clearly indicate the target set of KPIs and how it breaks the state of the art and is relevant in the 6G context. The proposals should be flexible enough to accommodate the view of KVIs and new relevant KPIs as they become available from the wider 6G community and from potential use cases. 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 Partnership. It is expected that software entities implement the target services in Open-Source Code and with open interfaces for further reutilisation in subsequent phases. 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 LST&Ps are expected to attract the participation of vertical industries in view of stimulating a strong European participation in future downstream standardisation phases. Therefore, participation of industrial actors with demonstrated strong standardisation impact is desired.

HORIZON-JU-SNS-2024-STREAM-D-01-01: SNS Large Scale Trials and Pilots (LST&Ps) with Verticals

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 10-15 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 26 million.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 5-7 by the end of the project – see General Annex B.
Funding rate	100% non-for-profit organizations, 70% for profit organizations

Expected Outcome and Scope

The target applications should cover 6G use cases piggybacking on the 6G vision, i.e. applications to eventually create a 6G network with a sixth sense that intuitively understands human intentions, making human interactions with the physical world more intelligent,

effective, and anticipating our needs (towards Internet of Senses); advanced VR/XR, massive twinning in various industrial environments may be considered though not limitative. This phase of pilots is expected to leverage new sets of 6G capabilities and KPI support as they gradually become available over time. For these applications, it is particularly important to demonstrate that the underpinning 6G architecture and technologies can scale up to the new set of requirements, can be implemented across heterogeneous technological and business domains, and can support innovation through openness.

It is expected that beyond the vertical sectors already quite advanced on 5G and structured around 5G Associations (e.g., Automotive with 5GAA and Industry 4.0 with 5G-ACIA), other less advanced sectors will join the initiative. This applies notably to sectors highly related to public policies like Healthcare, Energy and Public Safety, also more relevant in the COVID-19 and Green Deal context.

The detailed definition of this R&I SNS Call 2024 activity is subject to modifications and will be completed by Q3 2023 and annexed to the SNS Work Programme 2024.

HORIZON-JU-SNS-STREAM CSA, Coordination and Support Actions

Specific Challenges and Objectives

The development of next generation (6G) technologies requires to address multiple public policy objectives as well as existing and future legislation and guidance notably in the area of societal benefits, security/trust/resilience, sustainability and industrial competitiveness.

The SNS 2023 Work Programme includes a CSA project to address these issues and to identify potential non technological roadblocks towards wider acceptance of 6G technologies.

The CSA will i) contribute to raise awareness on the relevant framework taking into account various societal/policy issues; ii) provide services to EU projects to address these issues in their activities and relevant outputs.

The CSA should mobilise strategic and specific expertise to provide advice and coordination services on the relevant topics in relevant SNS Working Groups in cooperation with SNS projects and to be able to liaise with existing relevant international and European authorities, committees, working groups and expert groups concerning the issues of acceptability, inclusiveness, security/trust/resilience, sustainability and European industrial competitiveness for the next generation of smart networks and services.

Proposals are expected to demonstrate EU added value, with particular attention to cyber-security and other sensitive EU policy matters. In particular, the role of partners and their interests in the contribution towards the development of a sustainable digital supply chain from an EU perspective needs to be clarified.

A Second CSA is planned to be launched under the 2024 Work Programme in view of providing continuity to the overall program support, in view of optimizing coordination and take up of results.

Considering the strategic support nature of the CSAs, they should demonstrate a strong capability to tightly liaise with the JU Public and Private Members as well as with the relevant projects and stakeholders.

HORIZON-JU-SNS-2023-STREAM-CSA-01: SNS Societal Challenges

Specific conditions	
Expected EU contribution per project	The Commission estimates an EU contribution of around EUR 1 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 1 million.
Type of action	Coordination and Support Action
Funding rate	100% non-for-profit organizations, 90% for profit organizations

Expected Outcome

The CSA is expected to cover at least the following expected outcomes, in close cooperation with relevant SNS flagship initiatives and relevant EU and Member States or Associated countries projects:

- Summary of the positions of stakeholders on the impact of next generation (6G) technologies on the society and the expected improvements on citizens' everyday life.
- Technology acceptance model or roadmap building on outputs of relevant projects.
- Explanatory material (for non-experts) fostering a better understanding of the potential societal, environmental, public health, etc. effects of 6G and related technologies.
- General public information events and publications in non-specialised media, studies, citizen/end-user panels, open public debates with experts aiming at better understanding and promoting improved acceptance of 6G and its benefits where appropriate.
- Development of sustainability indicators, building on the Key Value Indicators (KVIs) developed by the SNS projects towards larger public validation and downstream exploitation at international and standardisation level where relevant.
- Advice for projects and other stakeholders on how to reflect EU policy objectives as well as existing and future EU legislation and guidance in SNS technology solutions for future networks' development and services where appropriate. Relevant areas include industrial competitiveness, cyber-security, privacy, environmental and climate action, as well as health.

Scope

The scope covers:

- At societal level, clearly identify why society needs 6G solutions and consider the acceptability of a new 6G technological wave. This will cover all aspects that may lead to acceptance and possibly adoption of a new technology by people, social sustainability and technology acceptability, including democracy, privacy and security principles, contribution to and impact on the society, and participation of the population are in scope as well as possible measures to address or improve the key factors of acceptability.
- It includes the potential effects at societal and environmental levels and on public health.
- From a sustainability point of view, analyse 6G contribution to the sustainability targets and a human-centric approach, with sustainability models for various application domains. Sustainability may be considered at large and should cover at least i) energy efficiency/carbon neutrality for various sectors; ii) energy and carbon footprint of current and future SNS technology solutions as well as related technology enablers and enabled applications; iii) affordability and accessibility considering the cost of technological solutions and the impact on availability and prices.
- Public policy objectives as well as existing and future EU guidance in various fields including, cyber-security, privacy, environmental and climate action, as well as health

that are important elements to be considered during the developments of new technology solutions.

- European technological competitiveness and digital leadership, notably in terms of position of European players in the supply chain and digital skills in the field of 6G technologies are of key importance. Activities under the SNS JU need to contribute to conceive, develop and deploy a European value-based approach to 6G (based on European KVIs and KPIs) and promote it through the 6G global standard setting process. Synergies with related SNS CSA projects from Phase 1 and other initiatives already in place (IPCEI on Microelectronics and Connectivity, Chips Act, etc.) may be considered.
- Intellectual property aspects and its valorisation through standards in a changing (software/IT influenced) digital world is in the scope of the project. In this context confidentiality of exchanges of data and their security are aspects to be taken care of.

The CSA shall provide advice and coordination services at SNS programme level e.g. in relevant SNS Working Groups and liaise with the SNS flagship initiatives and projects, and with the relevant CSAs - notably by cooperating with the existing and future SNS CSAs, the SNS JU office and the SNS JU private side - to exploit synergies. The CSA should integrate its work plan with the operational plans of the relevant projects and initiatives.

Considering the strategic support nature of the CSA, the CSA partners should demonstrate a strong capability to mobilise strategic scientific and interdisciplinary expertise on a broad range of societal issues as well as relevant EU legislation and guidance, and a strong understanding of the telecommunication sector, and be able to liaise with and leverage upon existing relevant international and European authorities, committees, working groups and experts groups around the issues of acceptability, inclusiveness, security and sustainability of next generation smart networks and services. Thus, the consortium should be able to handle the multidisciplinary challenge by bridging new technical capabilities and societal needs

The CSA activities and outcome should be specific to the scope of SNS, in order to respect the competence of other EU and international organisations and bodies. Also, the specific tasks and methodology of the CSA and the expertise needed (i.e. within the fields of technology, health, security, environment, social sciences, communication and media and economics) should be defined by focusing on concrete topical problems/questions.

HORIZON-JU-SNS-2024-STREAM-CSA-01 SNS Operations and Output optimization

Specific conditions	
Expected EU contribution per project	The Commission estimates that an EU contribution of around EUR 4 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 4 million.
Type of Action	Coordination and Support Action
Funding rate	100% non-for-profit organizations, 90% for profit organizations

This CSA project addresses the coordination of the Partnership activities. As the first CSA scheduled for the first phase of the SNS WP2021-22 will start early 2023, at least one CSA should be scheduled for the SNS WP 2023-24. This activity would start in 2025 (i.e., to be included during the call of 2024). The CSA will (among others) include collaboration with

Member States' or Associated countries' 6G initiatives and take cross-cutting issues like standardization, sustainability and cybersecurity into account.

The detailed definition of this CS SNS Call 2024 activity is subject to modifications and will be completed by Q3 2023 and annexed to the SNS Work Programme 2024.

Appendix 1: Additional Conditions of the SNS 2023 Call

Notes:

i) The SNS 2023 call conditions are based on the "General Annexes for Horizon Europe call conditions 2023-2024"[27], 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 2023.

ii) The conditions outlined in this appendix are complementary to the basic conditions outlined in the table provided in the definition of each funded topic of the SNS 2023 call.

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 from the Participants' Tender Portal.

Call identifier: HORIZON-JU-SNS-2023

Opening date: 17 January 2023

Type of call: single stage call

Submission of Proposals deadline: 25 April 2023 17:00:00 (Brussels local time)

Indicative budget: EUR 132 million

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).

NB: For proposals submitted under Stream B Topics **other than** the topics outlined in **Table App 2** of section 1.2 below, reaching the 6% IKOP programme level objective corresponds in average to 2,6% IKOP at individual proposal level.

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[28] 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;*

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

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

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

Indicative budgets by type of actions

Streams / Topics	Call 2023 Topic Budget (in M€)
HORIZON-JU-SNS-2023-STREAM-B (RIA)	
01-01: System Architecture	20.0
01-02: Wireless Communication Technologies and Signal Processing	24.0
01-03: Communication Infrastructure Technologies and Devices	12.0
01-04: Reliable Services and Smart Security	16.0
01-05: Microelectronic-based solutions for 6G networks	15.0
01-06: EU-US 6G R&I Cooperation	3.0
HORIZON-JU-SNS-2023-STREAM-C (RIA)	
01-01: Complementary SNS experimental Pan-EU federated Infrastructure	14.0
HORIZON-JU-SNS-2023-STREAM-D (IA, with FSTP)	
01-01: SNS Large Scale Trials and Pilots (LST&Ps) with Verticals (IA) – Focused Call	27.0
HORIZON-JU-SNS-2023-STREAM-CSA (CSA)	
01-01: SNS Societal Challenges	1.0
Total (M€)	**132**

Table App 1

Indicative timetable for the evaluation and grant agreement

Information on the outcome of the evaluation	Indicative date for the signing of grant agreements
Maximum 5 months from the final date for submission	Maximum 8 months from the final date for submission

1. Call management rules

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

1.1. Admissibility

Part A of the General Annexes to the Horizon Europe Work Programme 2023-2024 shall apply *mutatis mutandis* to the SNS call 2023 covered by this Work Programme, with the following derogations to page limits:

The limit for a full application is **100 pages for RIA's** submitted under Stream B, C, **and for IA's** submitted under Stream D. Proponents are encouraged to modulate the page number of their proposals, from an indicative 70 pages for proposals with low number of partners and very specific focus up to maximum 100 pages for complex proposals covering multiple technological dimensions and with large number of partners.

The limit for a full application is **50 pages for submission of CSA's**

1.2. Eligibility

Part B of the General Annexes to the Horizon Europe Work Programme 2023-2024 shall apply *mutatis mutandis* to the SNS call 2023 covered by this Work Programme, with the following amendments, mainly intended to support IKOP generation:

Actions	Restriction	Justification	Note
HORIZON-JU-SNS-2023-STREAM-B-01-05	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 of the Council regulation (EU) 2021/2085 establishing the Joint Undertakings under Horizon Europe. IKOP generation with long term commitment of new players from the microelectronics sector. The activities are supporting the objectives of the Chips Act and constitute cooperation between SNS and KDT Joint Undertakings towards microelectronics for 6G. It requires to be established and steered	Up to half of the budget fully open

		with long term commitment of partners and from the JU members other than the Union.	
HORIZON-JU-SNS-2023-STREAM-C-01-01	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 application of Recital 21 of the Council regulation (EU) 2021/2085 establishing the Joint Undertakings under Horizon Europe. IKOP generation with long term commitment and required stability as needed to develop the needed pan European test and experimentation infrastructure that spans the programme life time. It requires to be established and steered with long term commitment of partners and from the JU member other than the Union. This is needed to prepare for the large scale trials with sufficient stability.	Up to half of the budget fully open
HORIZON-JU-SNS-2023-STREAM-D-01-01	The call is restricted to the member other than the Union and their constituent or affiliated entities.	In conformity with Recital 21 and Article 5.2.(a) of the Council regulation (EU) 2021/2085 establishing the Joint Undertakings under Horizon Europe. Large scale trials require in that respect take up commitments from JU private member constituents.	Opening is established at up to 20% of the budget to incorporate specific actors/technologies/use cases on an ad-Hoc basis through financial support to third parties (cascading grants)

		The higher TRL projects will leverage and **complement the programmatic large scale platform for test and validation** of critical technologies and will be enhanced over time. This needs a long-term commitment of the participating entities and from the JU member other than the Union.	

Table App 2

For the above conditions, **a self-declaration** of compliance is requested at proposal stage.

Gender equality plans and gender mainstreaming:

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 2023-2024. Additional gender issues shall be addressed as appropriate in case research results are expected to differ when applied to different gender populations of users.

1.3. Financial and operational capacity and exclusion

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

1.4. Award criteria

Part D of the General Annexes to the Horizon Europe Work Programme 2023-2024 shall apply *mutatis mutandis* to the SNS call 2023 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 reinforcement of an EU supply side in the context of sovereignty;

- 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;

	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 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.	- 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 communication activities. - *EU added value in the context of EU supply side industry competitiveness and positioning in the supply chain* *- 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.*	- 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.

Coordination and support actions (CSA)	- Clarity and pertinence of the project's objectives. - Quality of the proposed coordination and/or support measures, including soundness of methodology.	- 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 communication activities.	- 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.

Table App 3

1.5. Documents

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

1.6. Procedures

Part F of the General Annexes to the Horizon Europe Work Programme 2023-2024 shall apply *mutatis mutandis* to the SNS call 2023 covered by this Work Programme with the following amendment related to the procedure to rank proposal with equal scores:

a) 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.

b) Specific case

Regarding the evaluation and ranking of proposals submitted under topic: *HORIZON-JU-SNS-2023-STREAM-D-01-01: SNS Large Scale Trials and Pilots (LST&Ps) with Verticals – Focused Topic*, the ranking of proposals will take into account the need to cover the two identified priorities under this topic, namely:

- Use Case Priority 1 on **connected and automated mobility (CAM) vertical and intelligent terrestrial transportation**.
- Use Case Priority 2 with following verticals (to be considered independently or in combination): **Health, Smart Cities, Farming, or Education**.

To ensure a balanced portfolio covering both aforementioned Priorities 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 two Priorities provided that the proposals attain all thresholds.

In that context, applicants are invited to clearly specify in their proposal under which Priority they are applying.

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

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

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

Part H of the General Annexes to the Horizon Europe Work Programme 2023-2024 is not applicable to the SNS call 2023 covered by this Work Programme.

1.9. Other Specific Conditions

The following additional conditions shall apply for the call covered by this Work Programme:

i) Project collaboration

The project contracted under this call will be expected to enter into a collaboration agreement to collectively work on topics of mutual interests. To that end, they will be subject to contractual clauses outlined in the relevant collaboration article of the Model Grant Agreement

ii) Security provisions applicable to Stream D

In order to meet the security requirements specified under Stream D above, all proposals submitted, shall have to include security declarations, which demonstrate that the network technologies and equipment (including software and services) in the proposed project comply with relevant security requirements and in particular, indicate that required documents, information and results related to equipment or services deployed or used within the proposed project will be duly protected and not lead to exposure of sensitive information in the cybersecurity context to entities not established in Member States or controlled from third countries. As part of the security declaration the proposal shall contain information that:

(a) Demonstrates that the infrastructure deployed within the proposed project shall remain, during the action and for a specified period after its completion, within the beneficiary/beneficiaries and shall not be subject to control or restrictions by entities not established in Member States or controlled from third countries.

(b) Demonstrates that for any equipment to be deployed for the implementation of the proposed project and/or used for the management and operation of the resulting digital connectivity infrastructure, the required documents, information and results will be duly protected and not exposed to entities not established in Member States or controlled from third countries. This should in particular apply to suppliers of equipment as well as suppliers of relevant services.

Based on this security declaration by the proponent, as well as the evaluation carried out by independent experts, the Commission (or funding body) may require security measures to be implemented in the project and/or carry out a security scrutiny focusing on the exchange of

project information, documents and results considered as security-sensitive information among project partners.

iii) Financial Support to Third Parties (cascading grants)

Financial support to third parties (FSTP) is planned for following topic under the SNS call 2023:

- SNS-2023-STREAM-D-01-01, IA implemented under Stream D. Up to 20% of the budget of proposals submitted under this topic may be reserved for Third Party Financing.

For these actions, the third party financing contractual clause **of the MGA will apply**.

The generic conditions are described in General Conditions Annex part B with the following complement:

Beneficiaries may provide financial support to third parties in the form of grants. The maximum amount to be granted to each third party is of EUR 300000 to support:

i) Additional 6G technological capabilities to the network and services test infrastructure;

ii) Additional technological capabilities needed to support target use cases submitted at proposal level;

iii) Additional vertical use case capabilities complementing use cases already included in the proposal;

iv) Expansion of stakeholder base as technology suppliers or users;

v) Expansion of proposed work in terms of additional pilot sites.

Proposals should provide a description of the use of the financial support to third parties, addressing:

- the targeted objectives and results;

- the reason why the target financing to third party requires to exceed the default EUR 60000 planned for such actions;

- the different types of activities that qualify for financial support;

- the criteria for giving financial support

It is recommended that the beneficiary providing third party financing is an entity eligible for 100% of reimbursement of the eligible costs.

****