6G SNS IA

The Voice of European Industry and Research for Next Generation Networks and Services

FP10 and Beyond SNS

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1. Introduction and Scope

This paper outlines a long-term perspective for Smart Networks and Services (SNS) in Europe, taking a time perspective across the FP10 implementation time frame. The structure of the paper covers three interrelated aspects:

i) **Why** a long-term European extended R&D perspective is needed for SNS.
ii) **What** activities should be covered within the FP10 time frame.
iii) **How** the proposed set of activities should be implemented to maximise impact.

These views provide a rationale for further expanding European support for the SNS technology domain in the FP10 timeframe, **building on the proven track record of success over the last 30 years**, as briefly outlined in Table 1 below.

Table 1: Track Record of R&I / European support for mobile network generations

Mobile Communication Generation	First introduction in Europe[1]	R&I/European support
2G/GSM	Radiolinja, 1991	Cost Programme on radio aspects; specific technologies; harmonized standard, spectrum and licensing rules following the industry GSM MoU of 1987.
3G/UMTS	T-Mobile, 2001	Key Research on radio and network (Frames, Rainbow…) leading to the ETSI UMTS landmark decision of 1999 for the UMTS standard with support from Japan.
4G/LTE	Telia, 2010	Launch of the Wireless World Initiative in 2004, (WWI) with key impacts in 3GPP and ITU-R on new Radio standard at 3GPP level.
5G NSA/SA	Telia, 2018	Launch of the 5G PPP co-Programme partnership in December 2013, Europe leading the development of 5G for vertical industries with dozens of successful trials and pilots, followed up by the CEF 5G for CAM as a spin off Programme. 5G PPP was the seed of the 5G Action Plan of the EU Commission in 2016 that led to a coordinated 5G introduction in Europe.
6G	intro around 2030	Launch of the 6G SNS JU in November 2021. Ongoing development of vision, technologies, use cases and preparation of standardization cycle, to be initiated mid 2025.

This paper represents the views of the 6G Smart Networks and Services Industry Association (6G-IA), who is the private side of the Smart Networks and Services Joint Undertaking (SNS-JU) launched in November 2021 under the current Horizon Europe programme. Today, 6G-IA represents:

- About 400 Members, including all key European stakeholders of the SNS domain.
- A substantial contribution to the EU economy, with 6G-IA EU-based board members representing about € 210 billion of revenues, and all 6G-IA EU industry members representing about €420 billion of revenue.
- A strong EU leadership with more than 120 operational 5G networks having been deployed by 6G-IA members and their EU ecosystems out of a total of 353 operational 5G networks around the world[2].
- A clear leadership on advanced networking technologies, with a focus on competitiveness, sustainability of ICT solutions, and sovereignty of supply chains.
- An undivided commitment to innovation, with typical R&D investments in the 20% range for large industrial suppliers, a control of about 40% of essential patents from 2G to 5G, and a lead towards the development of new vertical markets.
- An undivided support to collaborative research, with more than € 900 million in private investments in the EC 6G programme.
- An established partnership with more than 130 EU academics and RTOs and more than 100 SMEs.

Starting with a membership of 50 members at the launch of the SNS JU, the 6G-IA has successfully grown and mobilized a critical European mass needed to address 6G challenges. In this paper, it is proposed to capitalise on this asset by further expansion into a wider technological skillset and technologies that will be required to address the future challenges of the SNS domain as described in this paper.

2.Beyond SNS JU and towards the SNS+ JU

2.1 Smart networks and services are key for EU policies

At the time of the launch of the first R&I activities under FP10, the initial version of 6G will be close to deployment. In the subsequent decade, it is expected to see the global rollout of this technology and its subsequent further development. Whilst 6G will be introduced with early capabilities for various use cases, the next decade will be the time of 6G expansion into a multiplicity of "Operational Technologies" (OT) domains[3] which will in turn generate new requirements and new technological progress, in a spiral model that is typical of the sector. Multiple innovations, new technologies, and use cases may be expected to unroll during this time and it is considered that a strong public-private partnership approach will be necessary for the following reasons:

[2] https://www.5gamericas.org/resources/charts-statistics/global/

[3] OT, or Operational Technologies is a terminology used to qualify business sectors which are not ICT native and whose prime business is not a direct function of digital technologies, e.g. construction, transport... See also speech by Peter Vetter at the 6G Flagship conf in Levi, Finland, 2019.

- According to Eurostat, the information and communication services sector accounted for 6,7% of the business economy in the EU in 2021[4]. Additionally, the ICT sector's value added was equivalent to 5,5% of the EU's GDP in 2021[5]. The **EU needs to remain a lead market for advanced communication technology research, development, and deployment**, which may best be achieved if potential customers and implementers are well aware in advance of the technological capabilities and deployment prospects of innovative technologies. This is typically what collaborative R&I enables by stimulating early partnerships between the supply and demand sides. With an increasing number of vertical industries (OT sector) leveraging connectivity as an enabler of innovative business cases (e.g., not anymore as a cost factor for an enterprise network, but as a constituent of the product/service added value), use cases for smart connectivity are getting increasingly sophisticated and involve many more users than before. **The digitization of OT has proven to be a long-term process that will span the lifetime of FP10 and beyond**. The level of risk for value chain fragmentation is present and significant, thus justifying public sector involvement to catalyse market take-up and competitiveness. The Draghi report explains the key importance of the ICT sector to close the productivity gap between Europe and the US: ***"In fact, if we exclude the tech sector, EU productivity growth over the past twenty years would be broadly at par with the US. Europe is lagging in the breakthrough digital technologies that will drive growth in the future."*** **Significant investment in the ICT domain will help to catch up in these essential technology areas.**
- Beyond the demand side, the consolidation of EU leadership from the supply side is considered strategic for the EU. The Draghi report indicates: "*The **telecommunication equipment and software sector are also key for the EU's cyber-resilience, security of strategic infrastructures, and protection of citizens' and business data**. Strong EU champions in these fields are being penalised by the loss of access to the Chinese market, China's fierce competition in developing markets, and lower levels of investment in Europe. …. As network virtualisation progresses, telecom operators are looking for alternative software-based solutions to fully integrated equipment. …*". Therefore, it will be important to strengthen and further expand EU leadership from the supply side in the next decade, at a time when 6G will enable the emergence of a flurry of innovations similarly to 4G (and 5G), which enabled the birth of the "app economy". The expansion should also address digital technology areas, where Europe needs to seize opportunities, as in other regions, e.g., in AI, cybersecurity, cloud computing, data centres, IoT, blockchain, and quantum computing.
- **We can expect no rest from our main competitors, which will continue to support and invest in SNS technologies, with a growing contribution from the public sector.** This is due to the now widely recognized fact that **smart networks and services are considered critical technologies** and that dependence on external regions/nations needs to be minimized, whilst

[4] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Businesses_in_the_information_and_communication_services_sector
[5] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_sector_-_value_added,_employment_and_R%26D

keeping the goal of global standards. This is best exemplified by the US, which used to take a “market-led” approach to R&I for the development of communication technologies until the 5G times and primarily relied on industry to promote their standard with a hands-off approach, with an intervention primarily at the deployment side, with FCC decisions on spectrum allocations. This has somewhat changed for 6G, where the involvement of the public sector is much higher, with strong support to initiatives like the NextG alliance and dedicated Programmes at the NSF level to boost the emergence of US tech suppliers, notably in the context of open networks and Software/cloud implementation of networks. Other more classical regions have also increased their support to 6G developments: South Korea, with the 6G Forum, has ramped up support from 500 million $ for 5G in the last decade (1/3 public, 2/3 private) to almost 1 billion for 6G, with 80% from the public side and 20% from the private side; the Japanese initiative to support 6G has also almost doubled compared to 5G, with around 250 million $ for basic tech development and a similar amount for trials and pilot programs; Considering these figures per capita, the investment in South Korea and Japan is much higher than the one at EU level. China is also heavily investing in developing 6G, with a specific entity established under the MIIT ministry and driving the national Programme, the IMT 2030 (PG) Promotion Group. The need for such public support is also recognized in Europe, with several Member States launching 6G initiatives as outlined in Table 2 below (additional details on the scope and focus of each initiative can be found in deliverable D2.2 of the SNS ICE project[6]).

Table 2: Overview of EU based 6G Initiatives.

Member State	6G Programme	Budget (Euro, millions)
Finland	6G Flagship 6G Bridge	250 130
Germany	6G Platform Germany	700
France	France 2030 /PEPR 6G	part of 735
Netherlands	Future Network Services (FNS)	203
Italy	RESTART	118
Spain	UNICO 6G R&D (España Digital 2026)	206
Sweden	Advanced Digitalisation	210
UK	Wireless Infrastructure Strategy	100 (£)

[6] https://smart-networks.europa.eu/csa-s/#SNS-ICE

- **Sustainability emerges as an important aspect of future communication infrastructures.** This issue is already well addressed today under the SNS JU through 2 facets: Sustainable 6G and 6G for Sustainability. Sustainability goes beyond the energy efficiency and waste management of network platforms and is expected to be even more important when cloud implementation of networks becomes mainstream. **This is a long-term issue, including aspects such as coverage, security/resilience/trust, affordability, easy deployment, accessibility, etc., which will not only require further architecture and technological developments but also standards and eventual certifications**.
- From an investment perspective, **the sector remains one of the main R&D capital-intensive, with about 20% of the revenues of market companies reinvested in R&D, which is a minimum to ensure global competitiveness**. This level of investment is among the highest levels in the ICT industry, second only to the microelectronics sector, whose R&D is also extremely capital-intensive. The inherent risk associated with such long-term collaborative R&D also justifies a risk-sharing approach for critical technologies and consensus-building on fundamental concepts in the context of a public-private partnership. In addition, the risk-sharing approach is not the only motivation to invest in high R&D intensive domains. As outlined in the Draghi report (p. 229), the R&D intensity directly correlates with the labour productivity (c.f., Figure 1).

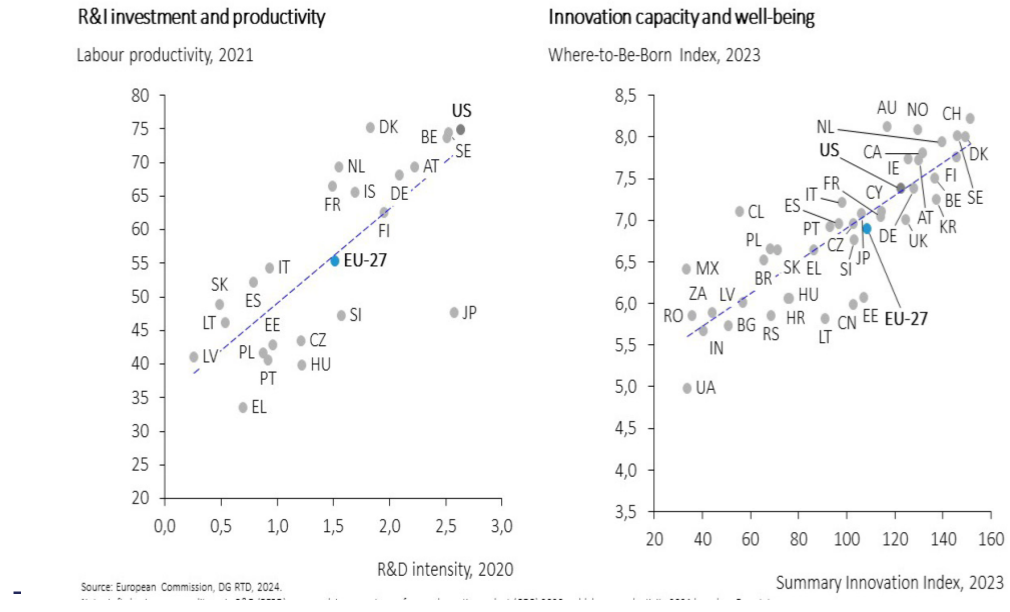

Figure 1: NB: Left, business expenditure in R&D in percentage of GDP 2020, and labour productivity 2021, based on Eurostat. Right, where to be born index by country 2023, Economic Intelligence and Summary Innovation Scoreboard, from European Commission DG RTD 2024. .

- It may be anticipated that the time to deploy the technologies will remain significant, which makes the collaborative R&I model very relevant. It can be noted that **the "G model" has governed the mobile industry so far, with one new generation every 10 years, and may not be applicable in the future.** Several ICT leaders have predicted the end of this "big bang" like model, with a more gradual introduction of targeted innovations over time at the infrastructure or service level. This is a consequence of the increased software implementation of networks, with shorter development times and cycles compared to equipment developed as specific hardware. However, the Open RAN model has shown that even with more agile/reconfigurable technology, deployment time remains significant due to the need for large-scale interoperability tests, certifications, and performance optimization. The very specific need of this sector to work with global standards naturally adds to the cycle of innovation, as beyond R&D, it takes about 36 months to develop a global standard (SI+WI) and another year to make the commercial products available.

- This is further exacerbated by **the take-up time of 5G/6G technology in the context of vertical use cases** because the number of requirements of the various target sectors (automotive, Industry 4.0, energy, healthcare, etc.) are much more diverse than the "classical" consumer broadband business and hence require much longer time for validation and adoption in an operational vertical context.
- In addition, the capabilities of **specific domains of very high value for the public sector directly depend on smart connectivity and services**. This is the case of the EU Critical Communication Systems (**EUCCS**), with the objective of moving secure and resilient mission critical communication systems into the broadband domain with associated contextualised digital services.
- The objective is to demonstrate the interconnection of national public safety/security systems across various countries in the Schengen area to support intensified cooperation across security forces. The aim is also to increase the resilience of the communications systems to deliver the target EUCCS. Whilst the objective is to move into an operational phase in 2030, including with the development of standards and governance models, at least three issues will justify the extension of R&I work much beyond the 2030 time frame, to keep the system capabilities in line with latest innovations and risks: i) **exchange of cross border data and applications**; ii) **resilience for critical infrastructure including the role of the IRIS² satellite infrastructure**; iii) how to **factor in emerging technologies such as AI, quantum**. These three issues were identified as long-term issues at a CERIS event of DG Home at the end of 2024. **FRMCS** may represent another domain of high public sector value and the current SNS programme already supports this flagship programme of DG Move.
- Beyond EUCCS, smart communication systems will be increasingly important in a Europe that strives to develop its **defence capabilities** further. Secure and robust communication is a key pillar of defence systems. In other regions of the world, dedicated programmes exist (e.g., DARPA) to use 5G in military contexts, potentially up to the battlefield. This is a domain that requires a dual-use approach of technologies, and the advent of 6G, by the end of the decade, will also require further adaptation and validation for defence purposes.

Beyond these mainly policy related issues (i.e., competitiveness, sovereignty, sustainability, security, public safety, etc) a programme for the next decade should go beyond a defensive approach focusing on "the risk for Europe" but rather **take an offensive approach with respect to the changing geopolitical situation leveraging the opportunities that are globally open in the digital world**. We can expect an even greater economic growth over the next ten years, materialised by the “Industry 5.0” era, which presents **opportunities of over USD 35 trillion** by 2035[7]. Various domains will offer these opportunities once ICT technologies are fully enabled and their operations have moved into a full digital domain. These domains are entirely in line and further expanding the long-term Hexa-X II vision for 6G and beyond, based on the coming together of the physical, digital, and human world. (See further description in Annex 1).

These new usages entail future evolutions and disruptions potentially driven by the insatiable demand for capacity. Existing models indicate an expected traffic increase from 500% to 700% during the next seven years[8, 9, 10,] as depicted in Figure 2.

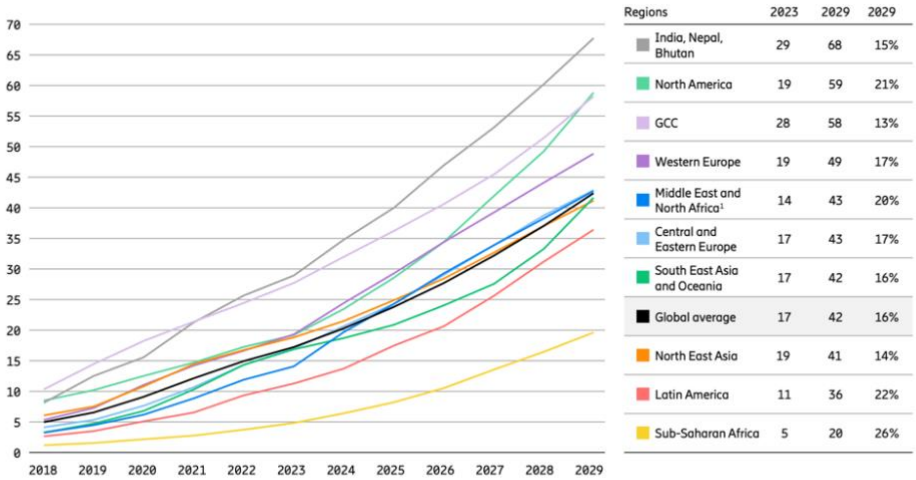

Figure 2: Mobile data traffic per active smartphone (GB per month)[11]

The scalability imposed by the sole traffic increase will **require multiple innovations, which will impact how traffic and the huge diversity of traffic profiles are managed**. The global market for Mobile Data Traffic was about 109 million Terabytes per Month in 2023 and is projected to reach 603 million Terabytes per Month by 2030, growing at a CAGR of 27.6% from 2023 to 2030.

The growth in the mobile data traffic market is driven by several factors, including the rapid deployment of 5G networks globally. With 5G, the capacity for handling data is significantly enhanced, but it also supports a higher density of mobile broadband users and machine-to-machine connections critical for IoT scalability. 6G will further increase the trend in the next decade with an expected soaring of machine-generated data. Figure 3 below shows the prediction, based on public data, in terms of data growth over the network when AI is deployed at scale. **The implication is that data alone won’t pay the bills in the age of synthetic content and ubiquitous AI. The real opportunity lies in building platforms, enabling AI-based service ecosystems, and cementing telcos as the trusted foundation for mission-critical digital services.**

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[7] https://www.forbes.com/sites/sarwantsingh/2024/12/19/35-trillion-dollar-industries-of-the-future/
[8] https://www.ericsson.com/en/reports-and-papers/mobility-report/articles/genai-impact-on-mobile-network-traffic
[9] https://www.nokia.com/blog/the-ai-revolution-preparing-for-a-surge-in-5g-uplink-traffic/
[10] https://www.ciena.com/insights/blog/2024/networks-will-shape-the-future-of-artificial-intelligence
[11] https://dpadocs.dpaq.de/20158_Ericsson_Mobility_Report_June_2024.pdf

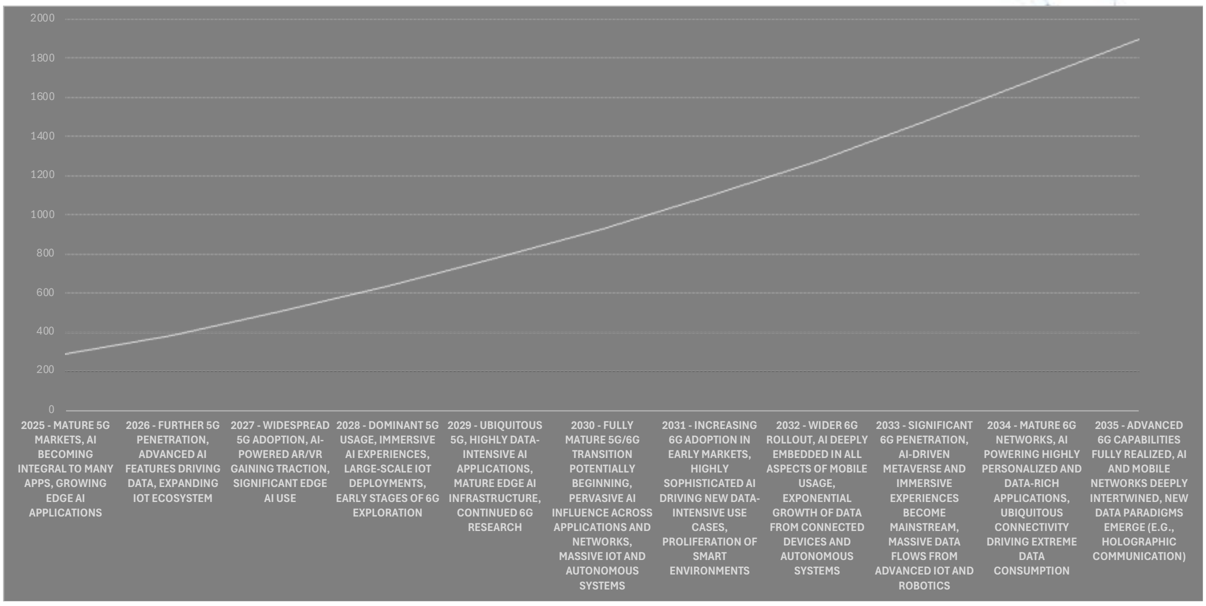

Figure 3: Estimation of AI-related traffic in mobile networks (EB/month)

Smart Networks and Services are central to realise the vision for full digitization of vertical industries. The huge data processing and analytics implied by **this vision require ultra-fast and reliable connectivity and computing capabilities within and between processing nodes** that may be local (as well as the realised service) or much decentralised, all being fully dynamic for agile reconfiguration. Whilst the first steps of this massive digital transformation will be supported by 5G and then 6G, **the full realisation of the vision will require significant efforts during the next decade, in partnership with the multiplicity of domains and actors involved**.

The overriding objective is to foster the transition of the European economy towards a significant extension of activities based on the platform economy to open **new businesses based on European values**. This would also accelerate the **transition from the low added value economy sectors** that are still composing the majority of businesses in Europe **towards higher added value economy**, considering that the market capitalisation of the platform economy is today significantly higher than that of the EU ICT economy (see Figure 4 below from Draghi report, p73). It would also **derisk the vulnerability of European supply chains**, where digital technology is gaining accrued importance, emerging from the changing nature of the geopolitical environment.

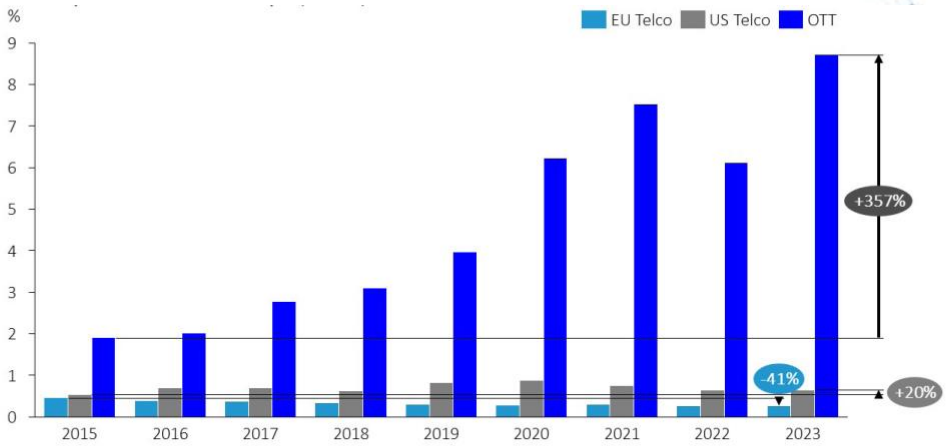

Figure 4: Comparison of the market capitalisation of the EU and US telecom sectors, and the top-five over-the-top (OTTs) in the US

2.2 Scope of a future SNS JU to address key pillars of EU policies

Taking a beyond 2030 perspective, the above considerations, coupled with several points developed in the Draghi report, suggest that **many intertwined technologies, systems, and use case issues will be worth addressing under FP10 at a moment when 6G will be in its large-scale industrial pilots/ pre-deployment phase**. From a policy perspective, the high-level goals of such an initiative should be:

- **Increase the global competitiveness of the European ICT industry** by leveraging European strongholds (and notably connectivity technologies and systems) and secure the capabilities to address new core technologies whilst promoting European capabilities towards our strategic international partners.
- **Leverage emerging disruptions**, and in particular **AI, advanced clouds and microelectronics** towards the creation of EU connectivity and service solutions.
- Platforms with **high added value and service monetisation capabilities**.
- **Support the emergence of innovative services** that can boost the European economy's growth, productivity and competitiveness.
- Foster **adoption of innovative and AI-based services by OT sectors** to boost downstream benefits and usages of network platforms.
- **Develop the European ecosystem, notably for software solutions**.
- **Regain ground on core technologies for (special-purpose) end-devices**.
- Provide **European solutions for critical areas**, such as the cloud continuum, that will operate under EU policies and safeguard the European citizen's privacy.
- **Promote the sovereignty of Europe**.
- Establish **Europe as a lead market** for future innovative advanced 5G/6G use cases.
- Develop new **R&D valorisation methods, e.g., dual use**.
- Support specific use cases corresponding to **EU policies such as EUCCS or FRMCS**.

From an economic, sovereignty, and competitiveness perspective, the above objectives are driven by two primary motivations outlined in the Draghi report:

i) **Supply-side:** Maintain and strengthen the capabilities of European industry to develop and market advanced solutions for SNS platforms addressing the services requirements of fully digital and sustainable environments, such as those promoted under Industry 5.0;

ii) **Demand side:** Promote the emergence of EU offers for advanced AI-based services, which can reposition Europe as a player in the provision of such services, fuelling digital growth and increased European revenues in high-added-value domains.

Because these objectives may correspond to different times to market, it is essential to consider different time horizons for the realisation of the supporting actions, and to take a full life cycle approach as advocated in the Heitor and PKH reports. Therefore, a target programme should include a mix of R&I and (pre)deployment stimulation actions.

To reach the objectives, it is proposed to adopt an approach targeting for a critical infrastructure, addressing an enlarged portfolio of technologies and mapping the Draghi report, notably:

1) **Networks as the infrastructure foundational pillar** and the stronghold that Europe can leverage to stimulate technological leadership in related domains (Draghi report annex, section 3.1).
2) **Cloud, AI, and quantum** as related technologies to contribute to the emergence of advanced and secure network/service platforms (Draghi report annex, section 3.2).
3) **Microelectronics,** as the enabling pillar of a multiplicity of network functions, from baseband processing to RF, as needed to reach a level of sovereignty for the overall connectivity platforms (Draghi report annex, section 3.3).

Within these domains, the specific approach beyond the current SNS JU is:

- **To take a top-down approach** from the onset, whilst non-network issues in SNS are mainly addressed from a bottom-up perspective, notably for issues requiring cooperation with other initiatives (e.g., Chips JU, HPC, Photonics, etc.).
- **To address complementary technologies from the SNS perspective** (i.e., AI, cloud, quantum, microelectronics, photonics), in view of producing focus and impact. As a matter of fact, designing an advanced radio front-end with advanced chipsets has little to do with designing power electronics for cars or even radar electronics for car collision avoidance. Therefore, it is imperative that the specific needs and requirements of network/service platforms are addressed in the ***system*** context of such platforms to reach results and global impact.
- **To consider SNS as one of the key technological areas** where Europe wants to play prominently. As a matter of fact, **the main key technologies addressed by the Draghi report** (i.e., Cloud, AI, Quantum, microelectronics) are the main enablers for future networks and services. All these technologies **need to converge collectively to support SNS**.

Therefore, SNS is an essential technological, business societal and political domain where Europe must continuously strive for excellence and lead the global race during the next years. In that context, ***network/service platforms should be considered as a key federating environment for technologies, similarly to the automotive*** sector where future vehicles are considered as the integration environment for a collection of technologies that are critical for EU competitiveness (Software Defined Vehicle).

Smart networks and services are a federating environment for enabling technologies. These technologies cannot be general-purpose but fine-tuned to the needs of secure, resilient networks through which advanced intelligent services will be offered.

2.3 Contributing to key ICT domains outlined in the Draghi report

Whilst networks & services remain the key federating focus of the proposal, it is important to outline how related key technologies may be addressed, and with which objectives. As SNS platforms are designed as an aggregator of multiple technological domains, they can make key contributions to each of those as follows:

1) Artificial Intelligence (AI)

AI emerges as a powerful tool to reposition the EU connectivity landscape, from several perspectives:

- **AI for Networks, from reactive to predictive full autonomous infrastructures**. The telecom industry operates in a high-stakes environment where real-time decision-making, data privacy, and operational efficiency are non-negotiable. For CSP's, network reliability is measured in five nines instead of three nines. The critical objective is to achieve downtime in the order of a second in a week where cloud providers can accept 10 minutes per week in comparison. To achieve that level of uptime is typically achieved through redundancy, failover systems, and real-time monitoring. In that context, innovation isn't solely about breaking into new markets—it's equally about finding smarter ways to drive efficiency and performance in mature ones. In 2024, the top 100 telecommunications operators globally generated a combined $1.75 trillion in revenue. Yet their operational expenses totalled more than $1.0 trillion. This overwhelming cost burden highlights a massive economic opportunity: the need to streamline operations and automate a wide range of tasks for CSPs. By focusing innovation on operational efficiency, CSPs can unlock new value—enhancing customer experience, boosting revenue potential, and optimizing network performance in ways that are both immediate and scalable. This calls for full autonomous networking. The **transition from current Level 2 to Level 4 full autonomous networking** represents a radical leap from partial automation to full network autonomy, fundamentally changing how networks are managed and optimized. At Level 2, automation is task-specific and largely manual in nature—operators use it to handle routine functions like fault detection, traffic steering, or provisioning. These operations are typically rule-based, reactive, and executed within isolated domains such as the RAN or core. Human intervention remains essential to interpret insights and initiate actions, which limits scalability and responsiveness. By contrast, Level 4 autonomous networks are self-managing and driven by intent-based policies. At this stage, networks can sense real-time changes in traffic patterns, user behaviour, or infrastructure conditions, then decide on the most effective response using AI and machine learning models. These decisions are executed autonomously through closed-loop orchestration, allowing the network to act and adapt without waiting for human input. Importantly, the network learns continuously, improving its decision-making over time. This evolution involves several key shifts: from reactive responses to predictive analytics; from static, rule-based logic to adaptive, AI-driven intelligence; from siloed automation to full cross-domain orchestration across the RAN, core, and transport layers; and from manual parameter tuning to dynamic, goal-based optimization. These capabilities are vital as operators will continue to face the growing complexity of 5G/6G, network slicing, and new service requirements like ultra-low latency, massive IoT or ISAC. Ultimately, Level 4 autonomy positions networks to not just respond faster, but to anticipate demand, prevent failures, and align operations to serve innovative services with high-level business intents—transforming the role of telecom infrastructure in the digital era, in a similar way as autonomy transform the automotive industry.

- **Networks for AI, from global to local service provision** and EU monetized services. Today close to 80 % of the Internet traffic is channelled through platforms of the large US Internet companies that are dominating the ecosystem. Whilst edge computing and inference processing at the edge is the model of choice to benefit from the characteristics of 6G networks (notably low latency and high reliability), the dominating models are not necessarily in line with such a vision as computation and processing tends to be centralized in large data centres with thousands of machines called upon to both train the models and generate the inferences. On the other hand, emerging technologies may allow to promote a different model. The recent presentation of the DGX Spark and DGX Station, two super computers, are moving AI into the personal era. With such devices, AI which was running so far in data centres is reaching the prospect of running into local "workstation like" computers. The first one includes a chipset capable of 1000 trillion operations per second whilst the second, even more powerful, integrates close to 1 Tbyte of memory. These technological revolutions imply that : i) a model can be created and fine-tuned locally; ii) Cloud API's are less needed; iii) data stays local, not in the servers of a big tech; iv) AI reaches the "personal" stage. Such a model coupled with the power of intelligent data collection and networking, opens prospects of radical new services that may be both generated and monetized locally, without having to revert to a non-EU based player. Very much the same as the network is deployed locally (in the EU), the data and computing infrastructure that can run fully locally provides a path towards sovereignty and EU competitiveness in domains where it is not the case today. At a moment when the US administration is further unleashing the potential for US companies to access all global data available from US-based infrastructures, local service developments emerge as a key pillar of sovereignty. As example, data collected across a complete city may be used to provide real-time decisions on how to regulate local car traffic with landscape awareness, police interventions, or to provide real-time updated digital maps. The provision of such services may also depend on available complementary cloud solutions, with various levels of distribution (edge, fog, swarm, etc.) and interdependencies between services and intelligent connectivity, which also represent a domain that is not mature today.

- Addressing the above issues to their full extent will require 6G deployment and availability to enable the R&I and validation on training models benefiting from the full interface capabilities of 6G at scale, and from the data sets, considering that the value of collected data sets over time will only increase as more experience is accumulated by the industry. With the emergence of open networks and technologies, it can be expected that large collections of data sets may be available for R&D, which will provide a competitive advantage for European entities exploiting such data sets. Already, the SNS is expecting projects to produce the first data sets for 6G networks. However, as AI is here to stay, further creation, collection, and evaluation of training data sets will be an ongoing process, especially when the vertical's uptake rate of 6G connectivity solutions increases. The FP10 time frame will provide a perfect window of opportunity to further progress on AI for connectivity and service platforms. In addition to the two issues outlined above, AI in the communication/service context will require in-depth understanding of: Agentic AI, as critical for building a robust, efficient communication architecture capable of empowering the next generation of intelligent agents. These agents will revolutionize how networks are managed, optimized, and secured, allowing for real-time learning, energy-efficient operations, and dynamic service orchestration.
- Introducing constrained AI techniques for optimizing energy consumption and resource allocation in real-time.
- Exploring serverless computing models for efficient backend service orchestration across multiple domains.
- AI embedded security and how the AI security architecture developed mainly for conversational AI may be mapped and adapted to protect network-generated data and their associated computing.
- AI techniques are also being considered for the vast majority of technologies that are called upon to be aggregated to form a network and service platform, in view of improving, securing, and automating operations, decreasing OPEX and CAPEX. The applicability of AI for these various domains is now starting to make inroads in the industry, as exemplified by the AI RAN alliance or the work on AI native architecture for 6G.

In the AI context, it may also be noted that **GSMA** released telecom AI benchmarks in advance of MWC 2025, driven by the recognition **that today's models are unable to support telecommunication technologies and standards, provide specialised telecom knowledge, or effectively support telecom decision makers, engineers, and researchers.** In real-world scenarios, this means that current AI models cannot be used by telecom operators to troubleshoot telecom network or service issues.

2) Cloud and Services

Cloud and Services are another related domain that should be central to an SNS follow-up initiative. This is a critical domain for EU competitiveness and the emergence of the EU as a player on the digital scene. The domain should critically exploit the current development on cloud under the IPCEI-CIS, HE Cluster 4, and SNS Stream C WP2025 project, to leverage open technologies towards deployment and creation of an EU cloud ecosystem, based on managed open-source repositories and test facilities. Under the FP10 time frame, the approach to address this domain should be more focused on large scale validation, pre deployment, and agreed set of EU services to deploy (e.g., CEF/DEP like). However, several issues may still be of R&I nature, notably those related to 6G architecture as a basis for innovative services and 6G introduction of AI, which will require continuous efforts towards vertical industries through advanced test platforms. Typical aspects of investigation compatible with the FP10 time frame would include: i) the proper coupling between service provision and infrastructure capabilities, in view of minimising the over provisioning of resources to minimise Capex; ii) the definition of a cross provider model that guarantees full interoperability and constant QoS/delivery across multiple players, especially for specialised connectivity; iii) the use of AI for the provision of user services (see above); iv) the service monetisation model that can offer EU players a possibility to compete with large-scale Internet companies; v) the framework making it possible to develop and market services in compliance with a complex EU regulation; vi) the service based innovation capabilities, which highly depend on the platform opening and the eventual emergence of communities of developers (e.g. for tailored vertical use cases) which is required to generate full market impact; vii) local services (see above), benefiting from specific network characteristics like low latency, and which may require very local and temporal implementation characteristics (example may include PPDR services for local fire brigade or police interventions, local stadium monitoring; viii) service development environment for networks: one of the great strength of hyperscalers is not the cloud infrastructure, but the hundreds of services they provide to develop application for their environments. These services make cloud offers (e.g., beyond telco cloud) viable and marketable.

3) Quantum

Quantum technologies are a vast field of investigation with a time to market in the 10-year time frame. Under an SNS expanded initiative, it is not intended to address all quantum-related issues. In particular, the long-term development of a quantum computer exceeding the capabilities of the most advanced computing platforms would be addressed elsewhere. Should such quantum computers become available, SNS+ could provide a test platform for such computers, e.g., within the management domain, where high real-time computational capabilities are needed for autonomous management and RT service delivery.

- This long-term issue lends itself to a “Quantum” chapter under SNS+, mainly focusing on quantum networking. Although still nascent, quantum networking has the potential to offer several next-generation advantages (long distance, reliability, security, embedded error correction…). However, multiple roadblocks exist for the commercial deployment at scale of quantum networking, such as: **Fragile nature of quantum information:** Quantum information is fragile in nature, which makes it susceptible to environmental factors, like quantum interference, decoherence, and signal loss. One can deploy quantum repeaters at multiple segments to maintain the accuracy of quantum networking. In addition, quantum operators must operate on the qubits during error correction procedures.
- **Complex manipulation:** From an enterprise perspective, the inability to copy the quantum state might limit many applications on a routine basis.

In these cases, quantum logic gates manipulate quantum information between nodes to enable transmission. However, quantum logic gates can't violate the no-cloning theorem (access implies distortion of information).

- **Slow communication:** A common misconception is that quantum communication is faster. However, quantum networking often uses conventional communication methods, like the traditional Internet, which uses optical fibre for communication.
- **Scalability issues:** Long-distance quantum communication is currently hypothetical because a quantum network with many nodes uses short distances to separate them. Quantum networks typically have fewer processors than classical networks. Quantum processors can generate fewer super-positioned or entangled qubits in quantum networking protocols.
- **High costs: Implementing and maintaining quantum networking requires** a high-cost investment. Quantum networking hardware and software also require high investments in technology, talent development, testbeds and infrastructure. High-budget industries, like governments, deep-space research, and cryptographic projects, better suit quantum networking.
- **Complex integration:** Quantum networking has its own standardization and interoperability requirements for hybrid networks. To integrate with the classical internet, a network must deploy many quantum processors. Moreover, the TCP/IP communication model and quantum networking work on different technologies, making it difficult to combine.

From that perspective, it will take years for quantum networks to operate commercially at affordable prices like current computer networks. An SNS+ quantum networking chapter under a future SNS+ JU would help derisk the technology and validate its use for specific use cases.

4) Microelectronics

Microelectronics is a fundamental pillar of future communication systems from multiple perspectives, from efficient spectrum usage to baseband processing. Currently, the microelectronics activities at EC level have been mainly driven by a limited number of markets, notably automotive and Industry 4.0 use cases. FP10 should be the time to fully develop a microelectronics strategy for communication and service platforms, in view of supporting sovereignty aspects. Developing the required components is a challenging task as it requires the integration of multiple technologies, from baseband to RF, across domains of microelectronics capabilities, where Europe has different levels of expertise. Baseband and packaging, notably, are two issues less mastered at the EU level, should be critically addressed. In addition, these developments should offer important opportunities to leverage the pilot lines developed by the Chips JU. Typical aspects driving this domain are:

- Whilst the current industry focus is on mid-band spectrum (7-24 GHz), decisions taken by the future WRCs are expected to lead to the opening of Sub THz communications for a range of applications such as “fibre-like” backhaul (a must with network densification) or multipoint access in industrial or high-density scenarios[12] [13]. This in turn requires the development of new technological capabilities, covering very wide bandwidth with minimal losses, frequency-dependent impairments, and high-power amplifiers with optimised nonlinearities. The spectrum range to be covered also requires efficient integration of heterogeneous technologies.

- The emergence of new technologies like Joint Communication and Sensing (JCAS) will require integration of heterogeneous technologies, very wideband transceivers (>5GHz at Baseband), and support of moderate to high spectral efficiencies.
- Sophisticated industrial applications will drive the demand for integrated sensors and RF, optical, and MEMS devices. Key requirements in this domain include larger data processing capabilities to cope with the bulk of edge data, integrated AI/ML processing for fast, low-latency filtering, and battery-less device capabilities.
- 6G further drives the need for SoCs designed to handle the high data rates and low latency requirements. These chips are expected to integrate various functions, such as digital signal processing, memory, and power management, into a single chip, making them more efficient and cost-effective.
- The emergence of AI/ML as a technology to be integrated at various levels of the 6G platform. 6G is currently being contemplated as an "AI native platform" (i.e., with systematic capabilities to exploit the high data volumes generated from within or outside the platform) in the wake of the current "cloud native transformation" currently contemplated by the industry. This may have multiple impacts at different levels, such as: i) the need to have powerful GPU technology capable of AI/ML assisted intelligent / reconfigurable management of radio waveforms as a function of traffic / channel characteristics, also enabling unification with NTN access capabilities; ii) processing capabilities as required to support AI/ML assisted security from an end to end or local perspective; iii) processing capabilities for real-time AI/ML assisted function placement/execution as a function of the use case scenarios, etc..
- The advent of new deployment scenarios based on RIS (Reflective Intelligent Surfaces) requires the availability of intelligent (AI/ML-driven) surfaces built using metamaterials to reduce EMF exposure of the general public;
- The move towards virtualised networks already started with 5G and is expected to continue and be enhanced by the emergence of 6G by the end of the decade. Microelectronics requirements are multiple and characterised by: i) the need for software implementations to reach performance levels on par with classical hardware-based implementations, especially for real-time radio functions where generic-purpose processors may not be enough. The need to avail from accelerators that may be incorporated in various platforms with virtualised implementations is important in that context; ii) the need to avail from open multi source supply chains, RISC V technology developments may be contemplated in that respect; iii) the need to optimise energy efficiency at processor level, whilst software implementation may lead to higher energy consumption.

[12] Hexa-X Deliverable 1.2, spectrum section: https://hexa-x.eu/wp-content/uploads/2021/05/Hexa-X_D1.2.pdf
[13] Next G Alliance Spectrum considerations: https://www.nextgalliance.org/white_papers/6g-spectrum-considerations/

Within this broad perspective of evolving requirements for communication-oriented chipsets, it is worth looking into the implementation of technologies characterised by high volume potential. Whilst the microelectronics developments for networks/computing platforms remain of high interest, it is also important for Europe to address a new generation of devices, to master a complete value chain. This should be a focus of an SNS+ under FP10 (see "device" section below)

Addressing systematically the above aspects of the Draghi report in the context of an SNS follow-up may be seen as stepping up the level of ambition of the initiative and moving in the direction of the Draghi report. Again, these may not need the same intervention tool to guarantee success. A service-centric initiative will benefit from longer-term R&I (e.g., for the AI-based services) and shorter-term deployment actions aimed at testing and validation. Also, such actions may benefit from linkages to other initiatives like HPC. The recent EC regulation on using HPC as an infrastructure to train AI models and algorithms (which is the focus of the US 500 Bn$ investments led by SoftBank) should be used as an alternative to train AI algorithms specific to the SNS platform.

2.4 Consolidating and Expanding European Network Strongholds

Beyond these aspects, more classical work on extended basic technologies, systems, and architectures needs to be considered. Similarly to the microelectronics sector, network-enabling technologies' evolutions and disruptions will not stop with the advent of 6G. As has been the case over the last 30 years, the domain will continue to be home to multiple innovations, be it at the Hardware or Software levels. As outlined in the Draghi report, Europe must continue to master the most advanced technologies and their introduction into a complete connectivity system. This is the first step needed to reach the level of technological sovereignty called for by the Draghi report. It is also required from the perspective of global competitiveness of the ICT sector, as well as of the vertical industries. **Achieving technological leadership is also related to the deployment speed of the advanced networks**. In addition, it can be observed that those regions with technological leadership attract the most significant parts of the R&D investments for further development of the technologies. During the European GSM dominance, Asia and the US invested significantly in Europe, notably for R&D centres. Consolidating and reinforcing Europe's technological attraction should positively affect foreign investments. To that end, Europe can count on a top-notch set of research centres frequently requested to work for non-EU companies and regions. These assets should be further leveraged under FP10. The following examples provide a **non-exhaustive list** of technological issues that will continue to be highly relevant to the industry from both a competitiveness and sovereignty perspective over the FP10 time frame:

Radio technologies will continue to evolve and be very relevant for leading-edge R&D, with technologies like ultra massive MIMO, RT high-speed processing, reflective intelligent surfaces, Intelligent waveforms with AI based radio access, full duplex at the device level being called upon to form the minimum "toolkit" for the industry to maintain its competitive edge at the complete system level. In addition, 6G will be the first network system spanning a huge spectrum range, from 700 MHz to potentially 230 GHz, with different deployment scenarios, from WAN to ultra-dense and indoor microcells. Whilst this opens new capabilities such as "Spectrum as a Service" with adaptive/dynamic spectrum selection as a function of the application type and requirements, it brings a new level of complexity as multiband front ends get more complex to realize. Typical technologies implemented today like carrier aggregation become much more complex in receivers with an expanding set of frequencies to choose from. These topics will undoubtedly become even more dominant by the decade's end, considering that the spectrum allocation in the higher range will be planned at the WRC 2031. Radio topics are critically dependent from the microelectronics sector at implementation level[14], and this issue may be considered in partnership with the Chips JU, as currently pioneered by the SNS FEM initiative. In addition, the European Commission considers spectrum optimization and spectrum sharing as important policy priorities in the communication domain. Still, since the advent of database-assisted spectrum sharing developed initially in the context of TV white spots usage, little technological progress has emerged in this domain. AI is raising many expectations here, but the maturity of AI for spectrum optimization will probably take time, as it needs to aggregate a huge amount of data to develop the right models and optimization strategies.

Virtualisation & cloudification, and the implementation of network functions in software running on cloud platforms, is another important trend shaping the industry of the future. The EC White paper on network infrastructures[15] has recognized this as a critical domain and is taking steps to develop the needed European capabilities and know-how. This issue may be considered a long-term goal, as the original focus on telco cloud may eventually evolve towards a user-centric cloud, as the 6G-IA paper on sustainability proposes. Eventually, it may be expected that the cloud frontiers blur across different domains (from far edge to core) belonging to different entities but working in collaborative modes. This vision will make it more critical to assess how the network functions are implemented, how the value is distributed, and how the market is organized. Virtualisation and cloudification may also be models for innovative approaches to implementing a single European telecom market through wholesale access to a pan-European backbone infrastructure[16].

At the Service level, this domain of work is also critical as it drives the service capabilities and the service configuration that may be offered to users to monetise the overall investments. These are highly dependent on the basic infrastructure choices (VM, containers, bare metal, etc.) and on the computing architecture (edge, far edge, fog, swarm, etc.) together with the retained orchestration platform (which may also be AI-based). This is a typical domain requiring both R&I and closer to market validation, and which will be key to reaping the benefits of the EC Cluster 4 investments in the downstream sectors.

Also, with 6G being developed as a (largely open) platform for innovation, it is expected that usages and use cases emerge after its original implementation that have not been predicted at the design stage. This is typically what happened with 4G (and 5G), enabling the emergence of the “app economy,” which was not anticipated at standardization time. In that context, innovative features will have to be defined to cater to the virtually infinite number of use cases and use case

[14] See e.g. the GaN leadership of China for radio transmitters, https://www.trendforce.com/news/2024/10/15/news-u-s-reacts-to-chinas-gallium-export-controls-with-new-initiative-for-diamond-based-semiconductors/

[15] EC White paper : How to master Europe’s digital infrastructure needs?, available at https://digital-strategy.ec.europa.eu/en/library/white-paper-how-master-europes-digital-infrastructure-needs

[16] Discussion paper of Pogorel & Co, confidential.

requirements that need to be supported by the platform, hence fuelling later 6G releases that will be developed during the 2030-2040 time frame. This is also a crucial domain to fuel shorter-term innovation, departing from the classical 10-year cycle of the "G model" that has prevailed for previous generations of mobile communication systems.

Finally, **cloud and services work may be called upon to support key policies of the EU, such as the EUCCS system**. The current work is primarily 4G-based (EPS) and not 5G (that would require SA implementation). For PPDR-related services, vendors' offers are mainly based on SDKs based on Android clients, which is potentially suboptimal in a domain supposed to be an application domain of the much heralded "sovereignty" concept. The domain may hence benefit from PPDR service development environments for security applications (e.g., crowd management in a stadium, security monitoring in an airport, etc.) developed and hosted in a cloud, with potential interest in the context of the Telco Cloud developments.

Software is poised to gain in importance in future communication platforms. Its importance will be evident both for the simplified upgradability of the networks in shorter time cycles and for the support of new services and openly use cases. The trend towards **openness leads the industry to develop APIs to cater to specific use cases and vertical requirements**. Today, an API like CAMARA is developed with broadband QoS requirements from META, security requirements from the finance sector, and positioning requirements from other sectors. As the 6G experience penetrates a larger set of verticals, new API requirements will emerge and must be translated into software products to provide the service capabilities that eventually make the cloud platform viable and marketable. This is only an example of software that will also be key to realizing the zero-touch requirements and full automation that the industry needs to slash OPEX radically.

Optical technologies are important from several perspectives. Working towards a full optical network will significantly increase energy efficiency and broadband capabilities. Such networks are a precondition for the broadband 6G network architecture and deployments. They are also important in security and resilience, as they are compatible with quantum networking, a trend that Europe strongly supports. Optical technologies are expected to be present at every network level and will move towards software control in the wake of the network virtualization and softwarisation trends. Advanced products like Tb/s PONs are considered long-term and fully in line with the FP10 time frame. Also, optical sensing is expected to be developed over the next decade to take full advantage of the sensing capabilities (at the service level) that 6G will introduce.

Satellite. The key satellite technologies for the competitiveness of the space industry are expected to be supported mainly by ESA/Space Agencies. However, as 6G use case capabilities expand over the next decade, it will be important to ensure that satellite systems remain compatible with service provision capabilities that remain close to those of terrestrial systems in the wake of the "unification concept" promoted by the space sector. Satellite systems should be part of the overall network architecture. 3GPP is already working in this direction.

Network security and resilience will remain essential aspects over the next decade and should be supported by advanced R&D. First, the increasing complexity of networks, of the technology and business domains that are aggregated to form a network (that may even be temporary), make it more complex to have a complete end-to-end view of the infrastructure and of the delivered services, that may be compromised at an increasing number of places. This trend will be exacerbated by the growing importance of software in network function implementations that will create more “access points” for hackers and attackers, which also depend on software development methodologies and tools. On the other hand, security and resilience are key aspects to fulfil the EC policy requirements to address network infrastructures as critical infrastructures.

Sustainability is emerging as a top priority for connectivity platforms to address. This domain is in its infancy and has been mainly addressed from the energy savings perspective, considering that this may also provide significant OPEX savings for the operators. However, with still growing data throughput in networks, the energy consumption remains a continuous issue. The domain is, however, much wider with technology called upon to address issues like accessibility, affordability, inclusiveness, availability of infrastructures, and many more. Whilst important sustainability gains may be expected from 6G networks, key sustainability gains should come from use cases eventually implemented over 6G platforms[17]. As the first 6G use cases will probably be implemented from 2030 onwards, the FP10 time frame will provide an excellent window of opportunity to address the issues further.

Devices (smartphones) represent a domain of technologies where Europe is not present anymore. The smartphone market is dominated by US and Asian actors, with no notable European presence. This is a strong weakness, and a large part of the value of the ecosystem is realized at the device level, including the microelectronics sector. Also, the distinction between networks and devices is expected to blur in the future. 6G promises to provide connectivity for an extensive set of devices; thus, it is crucial to initiate actions to regain ground in this domain, similar to the activities targeting a strong position in the cloud continuum. This may be facilitated by the variety of devices that 6G is supposed to address, where not all devices will need the most sophisticated capabilities of smartphones with the most advanced microelectronics capabilities (down to 2nm). Exploratory work may be started considering a simplified range of terminals, as suggested by the RedCap standard developed by 3GPP for 5G and beyond. At the implementation level, obvious synergies and cooperation opportunities with the Chips and HPC JUs are possible.

As outlined above, AI has a special role to play as it can be used in any of the above technological topics for computing, even at the device level.

This aspect also fully justifies a strong initiative on connectivity platforms under FP10. As a matter of fact, all the key technologies developed recently in the ICT domain (blockchains, AI, AI/ML, cybersecurity, IoT, advanced RAN, transport and core connectivity solutions, etc.) apply to networking use cases and are called upon to be integrated into networks. Therefore, networks appear as a key use case to promote the European uptake of these European-driven technologies and provide an important platform for **developing EU skills and technologies through a domain of EU excellence**.

Figure 5 below illustrates the target programmatic concept of an SNS+ JU under FP10.

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[17] E.g. a connected car may realize important energy savings through intelligent assistance on the best route to take for a journey.

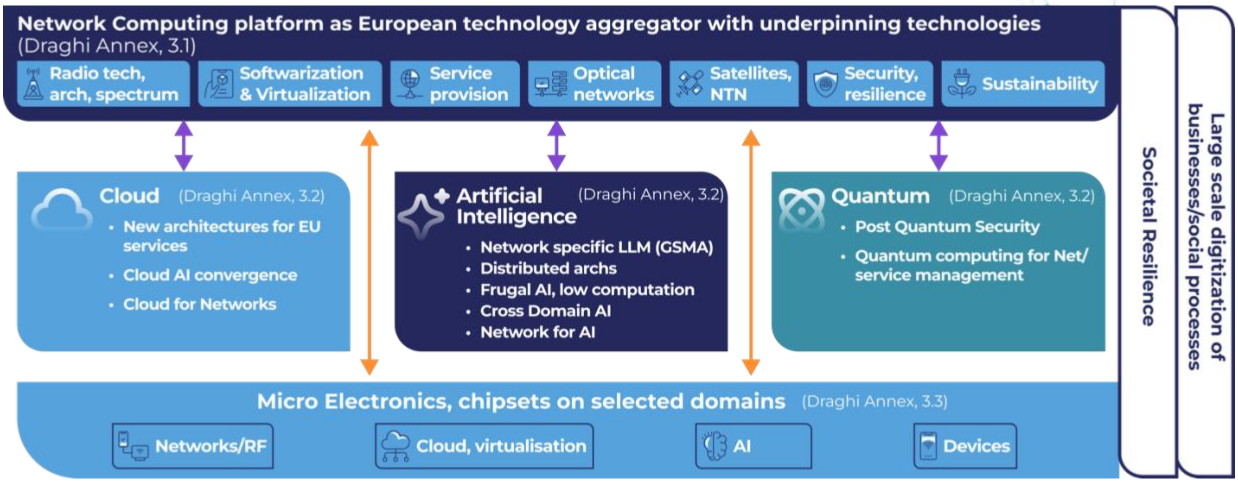

Figure 5: Target programmatic concept of an SNS+ JU under FP10

This digital tech aggregation characteristic of networks also calls for **reinforced efforts towards trial-end experimentation platforms, which are sufficiently large-scale to validate technologies up to high enough TRL (7), targeting their eventual use in operational networks and services**. These platforms should also be **large-scale** in terms of the spread of addressed technologies. This is part of a general trend in telecom R&D, exemplified by initiatives like the PAWR NSF Programme. In such programmes**, large-scale infrastructures are deployed at a city or regional level to test multiple co-working technologies that are getting closer to maturity**. This also alleviates the rising complexity of systems increasingly designed as Software systems. In these systems, it is possible to characterize software code "on the fly" and to code over the infrastructure to either correct errors or introduce new functionalities. This is also a clear trend in innovative implementation approaches like Open RAN, where operators increasingly develop large-scale test systems in partnerships with supply-side entities. This also has excellent prospects for engaging multiple SMEs and fostering the emergence of an EU ecosystem around these advanced infrastructures. Verticals will also use such large infrastructures to design, test, and evaluate advanced new services that will be used as best practices that will be adopted on a massive scale.

Whilst the above consideration is primarily related to a **technology push** supporting the supply industry competitiveness and European sovereignty, it is also important to consider **a market pull** approach through the quick deployment of advanced technologies and services, either for CAPEX/OPEX reduction or for RoI increase. This should be a core objective, considering that communication services revenues are rather flat in Europe (and elsewhere) whilst the service/Internet platforms capture monetization. This is well identified at the level of the Draghi report, which suggests corrective measures mainly at the regulatory level (e.g., pan-European consolidated/merged operators). However, technology, and notably 6G and future use cases, can further address this issue by introducing new classes of services that infrastructure operators can monetise (e.g., sensing-based services, a domain that is in its infancy and that will develop over the next decade).

Consequently, and **in line with the Heitor/PKH reports, which both recommend addressing a complete R&D cycle (from R&D to valorisation/deployment) it is important to boldly consider a significant part of the Programme dedicated to market take-up stimulation, with the clear involvement of lead users selected as a function of the most advanced verticals in Europe today.**

3.Structure of a new Programme

3.1 The JU Model: A Model that delivers

Compared to its predecessor Programmes, the SNS initiative was launched with a somewhat different context, reaching out beyond classical R&D competitiveness objectives and including:

- The requirement to tentatively cover a complete value chain, from component to application, is not only focused on connectivity services.
- The need to consider security from the onset, as networking platforms are now regarded as critical infrastructures.
- The need to safeguard sovereignty and reinforce European leadership in a domain that is considered strategic for Europe, not only from a pure commercial/competitiveness perspective.
- The need to take on board the users, i.e., the possible demanding use cases emerging from vertical industries, from the onset.

At this juncture, and midway through the implementation of the SNS JU, it may be noted that the JU is well on track to achieve its objectives, namely:

- The **core 6G technologies have been identified and are extensively researched** in European projects, paving the way towards EU industry competitiveness and readiness to deploy when maturity comes.
- Compared to previous Programmes, **sustainability has been introduced as a key design/research driver**, and several core technologies are being developed to support the sustainability of future networking platforms.
- **Key verticals are involved in a multiplicity of platform trials**, paving the way towards the emergence of use cases reaching beyond 5G capabilities and enlarging the traditional customer base of communication systems.
- In addition to working with vertical industries, significant work **beyond the "network silo"** has been launched, notably in the **Chip domain**, to establish links with the Chips JU. A similar cross-domain work is being prepared with the cloud computing tech domain to respond to the EC White Paper on Infrastructures. Moreover, a collaboration with the Rail JU has already been implemented, and efforts have been made to establish similar structured coordination with the Photonics21 Partnership. These efforts are naturally limited by their bottom-up nature;
- Along the same cross partnership line, SNS (and its 5G PPP predecessor) is at the heart of the **integration of satellite (NTN) networks within 5G and 6G** (TN) through a major spin-off in standardisation, notably the landmark standardisation output of 3GPP in 2023, under the SA group, which for the first time delivered a complete set of specs for satcom in 5G;
- A significant mass of European expert companies/entities has been mobilized, with **more than five hundred (500) entities in the first three calls and more than 30% not being part of the 6G-IA (the private member of the SNS JU), showing the JU's open profile**. Moreover, **25% of the funding is received by SMEs**, boosting the European ecosystem on SNS.
- The **level of IKAA mobilized by industry is already significant** and well in line to reach the target by the end of the programme.

- **Links have already been established with standardization bodies** (like ITU, 3GPP, and ETSI) to prepare for the standardization spin-off of SNS R&I results, and projects have already started promoting their results to them.
- Beyond R&I, SNS is **significantly involved in pure deployment initiatives like CEF** through the provision of the Strategic Deployment Agenda (SDA), which frames the implementation of 5G for CAM in Europe. SNS is not active in DEP, which is found to be suboptimal at this stage.

These few elements indicate that **despite its limited budget (the smallest from all the JUs)**, SNS is already implementing today various of the Heitor report recommendations, notably:

- The need to work across siloes and beyond the natural boundaries of the SNS domain.
- The need to avoid fragmentation and to mobilise a critical mass at various points of the value chain.
- The need to consider a full life cycle and R&I spin-off strategies.

- SNS successfully addresses EU targets for the full value chain of SNS in an open, competitive, and vibrant pan-European ecosystem of large industry, research, academia, and SME stakeholders.
- SNS is an excellent example of a cross-initiative operating instrument contributing to a cohesive Horizon Europe Programme.

3.2 Structuring a new SNS JU

The context, potential markets, objectives, and content are critical to defining a successful program under FP10, responding to the Union's main policy priorities while consolidating the European industry footprint. However, **the shape and characteristics of the implementation tool are also important to get maximum impact from limited resources**. The issues below are considered key to designing the right implementation environment.

- The **partnership model currently running for the SNS is favoured by industry and European stakeholders as it provides a stable environment with long-term visibility to stakeholders and a clear roadmap, with the possibility to steer the activities flexibly per the EC policy priorities**. Current SNS work on chips (Chip JU connections) and Telco cloud (EC White paper policy steering) are good examples of this flexibility and the short reaction loop between public policy interests and private industry interests. In a domain increasingly driven by public policy concerns, the current JU model offers the most operational implementation of public-private interactions. These do not occur at the level of a yearly call (as is the case with Cluster 4 actions or even cPPP) but take place on a quasi-weekly basis.
- **A strong long-term R&D pillar,** along with the R&D topics identified above, is needed. **Collaboration across various entities is needed, fuelled by the SRIA**. The industry feedback loop is needed to select from the SRIA throve of actions the most strategic ones with the highest market/spin-off potential. AI and Services are called upon to have a

central role within this pillar. Still, given the need to work with large data sets that are difficult to obtain, the EC should consider modifying the model contract so that data owners are guaranteed enough confidentiality and control over the data they may make available.

- **Such a long-term pillar needs to be complemented with an experimental pillar**, making it possible to validate at-scale promising technologies whilst also creating ecosystems of developers, which would eventually **nurture the development of a software and services ecosystem for networks in Europe**. This is **a domain where cooperation with Member States' developments may be stimulated,** as suggested in the PKH report on partnerships. In addition, such **a Pillar could be open to dual-use experiments** in the context of specific requirements from defence users. This experimental activity is also necessary to facilitate the development of innovative use cases on the most advanced infrastructure.
- To materialize the "full life cycle implementation" identified in both the Heitor and PKH reports, **a third pillar on technology valorisation/market take-up is required**. This type of action is currently taking place outside of the Horizon Europe umbrella through instruments like CEF or DEP. In addition, the market domains are primarily driven by the public side (e.g., CAM), whilst the private actors may have different views. It is hence essential that FP10 closes this gap and that CEF/DEP-like actions are integrated under the FP10 legal basis, thus enabling the launch of different types of calls with various stakeholder profiles. It may be much more efficient to realize full complementarity and efficiency between those technologies that are not yet mature enough and require "treatment" under pillar one and those mature technologies that can be brought to the market for wider take-up. Such an integrated approach would also be more in line with the "competitiveness fund" approach promoted by President Von der Leyen and would also facilitate the coordination role that SNS is potentially granted in the EC White Paper on infrastructures. This is also important to feed the market quicker with innovations and collect needs and requirements from end users. It would also directly support the ambition of getting quicker to market with innovative service offers. Figure 6 below illustrates the target concept.

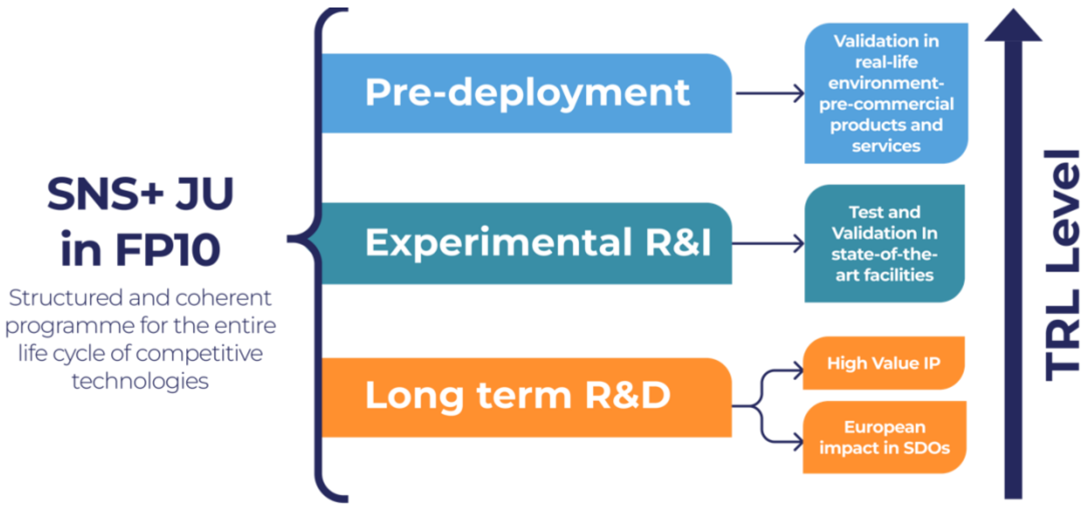

Figure 6: Target Concept of SNS+JU in FP10

- Regarding pillar 1 (i.e., long-term R&D), it is suggested that in line with the current "SNS expansion" approach (containing topics described in section 2.3 & 2.4), a bold initiative on terminals and devices is also launched. This may be prepared by a CSA project at the end of SNS (same model as CoreNect), to identify the boundaries and stakeholders of this new activity compared to SNS. Such pillar is expected to deliver significant results in terms of high-value IPRs and an increased European footprint in global SDOs.
- Pillar 2 targets the development of open pan-European platforms where state of the art technologies will be widely available to European stakeholders to develop, test and validate their solutions at a pre-commercial level. This is critical especially where verticals need to understand how the new technology can help them improve their operation and create revenues for them. In the context of this pillar, addressing the SNS limitations and in line with a bolder ambition, it is proposed that the future Programme includes, from the onset the means to boost incubation and startups. Such an activity could in the first place, be entitled to research centres with a strong track record towards incubations, e.g., RTO-like centres. In that context, the public budget could be more limited as "seed money", the financial objective being primarily to raise money from the private market. (Targeting a high leverage factor for the EC budget).
- International cooperation is essential for global standards and the creation of ecosystems. The second pillar (experimental facilities) would be a powerful tool to stimulate international collaboration with test infrastructure that players outside of Europe could use. These may also encourage take-up in developing/promising countries to anchor them to European solutions (e.g., Africa and Latin America, where non-EU pressure is firm).
- From a stakeholder perspective, involving potential tech users from the onset is key. In particular, a wide set of vertical industries will contribute to the success of such an initiative through active involvement in submitting requirements and in running experimental trials or preoperational pilots. Considering that such actors have limited resources for a domain that is not their core business, specific actions would be needed to be attractive. In addition, the proposed greater synergies between long-term R&I actions and deployment actions make it possible to mobilise critical masses of actors with different interests consistently. The supply side industry will be more focused on longer-term R&I, whilst service providers will be attracted by pre-deployment and validation actions;
- In parallel, more mature solutions need to be validated in real-life environments (pillar 3). As the new network technology needs to be evaluated via pre-deployment, such as large-scale pilots, which enable the creation of new ecosystems and services, facilitating in turn early deployment. In the context of the current state of the European connectivity sector's financial health and limited 5G investments in Europe it is unlikely that early real-life environment pilot deployments of

6G networks and software solutions (including telco-clouds and services) will emerge without public funding.

- At the level of synergy, specific ex ante collaboration may be identified, which could already be indicated at the legal level, through the successor text of the SBA. This potentially should include:
    - Ex ante agreement to use HPC capabilities to train AI models and algorithms.
    - Ex ante agreement with the Chips JU, e.g., in the context of device or networking hardware.
    - Ex ante agreement with other partnerships as appropriate.

Annex: Large-scale digitisation, industry 5.0

Industry 5.0 is considered the next major global revolution, moving multiple OT (vertical) domains beyond the Industry 4.0 era of digitalization into a space where organizations leverage data and information to their full extent and “for good”. Whilst business performance remains a key driver, Industry 5.0 includes environmental, social, and governance issues that guide how a business is run and how it impacts the rest of the world.

As a simple example, Industry 4.0 was designed to create smarter factories, but Industry 5.0 is designed to create more responsible factories while maintaining all the benefits of the 4.0 digital transformation era.

Industry 5.0 expands on digital transformation and shifts the primary focus to three distinct new efforts: building sustainability, creating resiliency and security to operations, as briefly outlined below.

Sustainable business is good business: Companies embracing digital transformation initiatives have uncovered immense value in their data through information sharing and the application of tools like analytics and AI. This operational insight, in turn, opens opportunities for sustainability improvements. For example, greater visibility across the supply chain can streamline operations to reduce waste and energy consumption. While many organizations initially adopt sustainability improvements for cost savings, these can also positively impact their marketability.

Agility supports resiliency: The pandemic proved the importance of agility when the unexpected happens. More agility is needed to improve operational resilience, which is expected to benefit significantly from AI and data analytics’ systematic introduction in business processes (e.g., to reshape quickly the supply chain, the treatment of a patient, the route of a car journey, etc.).

Security builds trust: The massive data processing, the multiplicity of computing points, and the variety of algorithms called upon to realize the Industry 5.0 vision require solid security foundations beyond the pure networking domain to make the complete system viable and trustworthy.

Regarding the top Mega Themes identified in Section 2.1, the potential opportunities are briefly discussed:

- **Hyper-connected World**
  A hyper-connected world features ubiquitous connectivity, integrated devices and systems, and real-time communication in a data-driven ecosystem, allowing for global or local interconnectivity and the adoption and advancement of automation and smart technology. The push toward a hyper-connected world will impact the global economy by an estimated **USD 12.3 trillion by 2035**, driven by advancements in 5G+, 6G, Industrial metaverse technology, and smart infrastructure.
- **AI Revolution**
  AI revolution refers to the increased adoption and use of advanced artificial intelligence technologies and automation. AI's most significant benefits include the automation of complex tasks, data-driven decision-making, closer integration among industries, the emergence of autonomous systems, and advancements in machine learning and deep learning. The AI revolution has a future potential of approximately **USD 10.6 trillion by 2035**,

mainly riding on the success and growth of data centres and advances in multiple domains.

- **Energy Transition**
  Energy transition is the move from traditional fossil fuels to cleaner, greener, and renewable energy sources. The main aim is to combat climate change and move toward a sustainable, low-carbon future, with a potential output of **USD 8.9 trillion by 2035**.
- **Future of Mobility**
  The future of mobility will be a game-changer, offering potential opportunities of **USD 2.7 trillion by 2035**. Advancements in battery technology and the emergence of EVs and autonomous vehicles can change how the world travels, while the aggressive launch of software-defined vehicle models by car companies will give rise to new vehicle features and revenues.
- **Electrification**
  Electrification has an estimated potential of **USD 2.3 trillion by 2035**. The shift to electrification, partly due to most countries having an aggressive net-zero carbon emission target, will transform multiple industries and infrastructure, especially the future of mobility, giving rise to a new generation of electric vehicles with greater range and zero emissions. Electrification will also boost the battery energy storage market and charging stations, with about 24.1 million charging stations sold annually in 2035 from about 5.6 million units in 2024.
- **Future of Healthcare**
  Healthcare spending in the Western world is already, on average, higher than 10% of GDP. Advancements in technology, coupled with data-driven insights, have allowed us to move towards preventive and value-based care. Robotics-assisted non-invasive surgeries are becoming more common, increasing success rates and reducing recovery time. The increasing use of AI and ML in healthcare has resulted in quicker, more accurate predictive and preventive diagnoses, improving patient outcomes and reducing costs, and breakthroughs in genomics and biotechnology, allowing for gene editing and targeted therapy. AI and ML will give rise to faster access to new life-saving drugs, while innovations in wearable technologies have greatly assisted doctors in real-time monitoring and consulting. As healthcare evolves, adding a potential **USD 1.8 trillion to the economy by 2035**, the focus on accessibility, affordability, and innovation is set to revolutionize how care is delivered and experienced globally.
- **Food and Materials**
  Advances in sustainability and the need to address climate change and resource scarcity will take the food and materials industry to new heights, creating potential opportunities of **USD 1.5 trillion by 2035.** Due to the increasing focus on health, food production based on plant-based food may become one of the fastest-growing markets, based on Innovations in biotechnology, precision agriculture, and lab-grown alternatives. For materials, similar advances have led to the development of sustainable materials such as bioplastics, plant-based composites, and recycled alternatives that are revolutionizing industries, reducing dependence on non-renewable resources, and cutting waste.

- **Autonomous Era**
  The future of the autonomous era will present opportunities worth **USD 1.4 trillion by 2035,** powered by innovation in AI, ML, and other related technologies. Autonomous systems, from driverless vehicles to autonomous home appliances, are on track to make our lives easier, more efficient, convenient, and safer. Autonomous systems are reshaping the way we work, right from agriculture (precision farming) to healthcare (robotic surgery and diagnostics), manufacturing (autonomous robots and drones), and logistics (automated delivery networks).
- **Future of Space**
  Over the last few decades, there has been an increase in the number of satellites sent to space, and this number is only set to grow—over 20,000 satellites are planned to be launched between 2022 and 2030. The future of space will present opportunities of **USD 0.9 trillion by 2035**.