6G Smart Networks and Services: Global Strategies, Main Work Directions & Future Outlook

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***Abstract*— Europe's Research and Innovation activities towards the next generation of mobile connectivity standards (6G) are well underway via the Smart Networks and Services Joint Undertaking (SNS JU). The SNS ICE coordination and support action project, which is the de facto ambassador of the SNS JU, is tasked with monitoring and reporting global 6G trends to the SNS JU as well as promoting the SNS JU work to the world. This paper presents SNS ICE's approach and designed framework to accomplish these bidirectional activities, targeting the establishment of the SNS JU achievements within the global 6G ecosystem. In doing so, this paper also highlights the key strategies of the SNS JU, summarizes the global status and roadmaps of major standards organizations with regards to 6G and provides insights into the main messages extracted by the SNS JU projects' work so far. Within this context, the future directions of the SNS R&I work are also discussed.**

I. INTRODUCTION

The SNS-ICE project (Smart Networks and Services International and European Cooperation Ecosystem) [1] is the de facto ambassador of the Smart Networks and Services Joint Undertaking (SNS JU) to the world. This entails bidirectional flow of information in terms of (i) analysis of the trends and reporting the B5G/6G Research and Innovation (R&I) activities in other regions to the SNS community; and (ii) disseminating and promoting the R&I work of SNS projects to the rest of the world. By performing a mapping between the globally considered 6G use cases and KPIs, the current status and plans of major Standards Developing Organizations (SDOs), the outlook for 6G spectrum allocation and usage (WRC 2023) and the SNS Joint Undertaking roadmap, it can be observed that European research is very well aligned with the global trends and roadmaps and European partners and key organizations remain well connected with the global ecosystem and spearhead developments in certain sections.

This paper summarizes part of the activities carried out by the SNS-ICE project in the course of its first year. This includes work towards the establishment of global dialogues and cooperation activities with other regions of the world, the identification and fine-tuning of the SNS messages to be conveyed in these fora, the collection of feedback towards the definition of future SNS R&I Work Programmes, along with an outlook of selected standards development organizations and spectrum harmonization activities.

In Section II, we present the current status and the approach to create and further boost a truly global 6G SNS ecosystem and to stimulate consensus building. This includes, on one hand, the elaboration and implementation of bi- and multi-lateral MoUs with international organizations (e.g., Next-G Alliance, the IMT-2030 6G Promotion Group); and, on the other, the elaboration of position papers and roadmaps. The strategy to foster collaboration with other world regions in the SNS R&I work programme and how it fits into its overall logic and roadmap for the coming years are presented as well. In the process of establishing international dialogues, it is of utmost importance to fine-tune the information received from SNS projects in order to create the global SNS message. The methodology adopted by SNS-ICE to down-select and fine-tune those messages, as well as an initial selection are discussed in Section III. Complementarily, SNS-ICE provides some suggestions towards the definition of the upcoming Work Programme which follow from the monitoring activity, observations and lessons learnt in the execution of the SNS-ICE project to date. Finally, in Section IV, we outline the approach followed by the 3GPP, ETSI, and ITU towards developing and standardising 6G. Playing a key role in SDOs and making sure the aforementioned SNS messages are properly conveyed in these fora will be of utmost importance in the coming years. This will help strengthen the positioning of the European telecommunications sector, ensure interoperability and global roaming of the proposed solutions and, ultimately, reap substantial economic benefits for the industry. The main highlights from ITU's World Radio Conference (WRC) 2023 are discussed as well.

II. SNS-ICE GLOBAL ECOSYSTEM & ROAD-MAPPING

This section reports on the current status and the approach to create and enhance a truly global 6G SNS ecosystem and to stimulate consensus building with different key stakeholders.

A. Building a global 6G ecosystem: MoUs & Letters of Intent with worldwide organizations

The elaboration and implementation of bi- and multi-lateral Memoranda of Understanding (MoUs) with international organizations lays the grounds for the creation of a global R&I ecosystem towards collaboration in 6G. The fact that this ecosystem is already truly global is illustrated in Figure 1 below. Some of those links between the 6G-IA and peer organizations were already established under the umbrella of

the 5G PPP, and further strengthened on the road to 6G networks. In addition, new MoUs have been stablished with the German Platform for future communication technologies and 6G (**6G Platform**); and the Taiwan Association of Information and Communication Standards (**TAICS**), an industry organization aimed to bridge the local industry with global standard initiatives. Besides, the 6G-IA [9] has signed an agreement with the **IMT-2030 (6G) Promotion Group**, a platform to promote 6G R&D and international cooperation which drives cutting-edge research on 6G technology and industry in China. Last, one more agreement has been signed with the **NEXT-G Alliance**, an initiative to advance North American wireless technology leadership over the next decade through private-sector-led efforts, with a strong emphasis on technology commercialization. Several activities in collaboration with those organizations such as the 6G EU-US roadmap jointly developed by the 6G-IA and ATIS Next-G have already taken place (see next subsection).

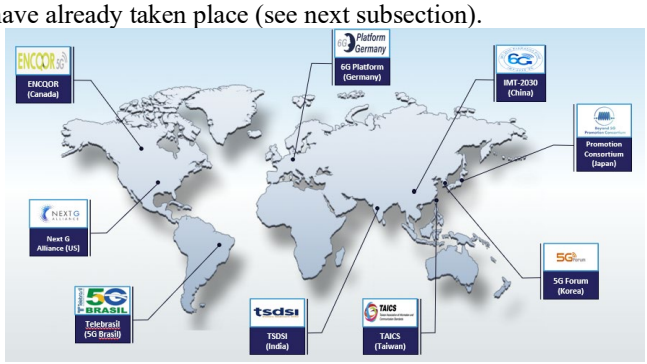

Figure 1: MoUs with international peer organizations.

SNS ICE is also very active in increasing the active engagement of stakeholders from vertical sectors, associations, standardization and regulatory bodies. Figure 2 provides details about all the bilateral agreements that the 6G-IA has established with such organisations. Since SNS-ICE started, additional MoUs have been signed with the world's leading alliance of public service media (5GMAG); the Transcontinuum Initiative (TCI), a collaboration between 8 European associations and projects towards the definition of the infrastructure required for the convergence of data and compute capabilities in edge industrial and scientific use scenarios; the Association for European NanoElectronics ActivitieS (AENEAS), an industrial association in the field of microelectronics components and systems; and, finally, SCoDIHNet an initiative contributing to the European Industry Digitalisation by helping companies to improve their processes, products and services via the use of connectivity.

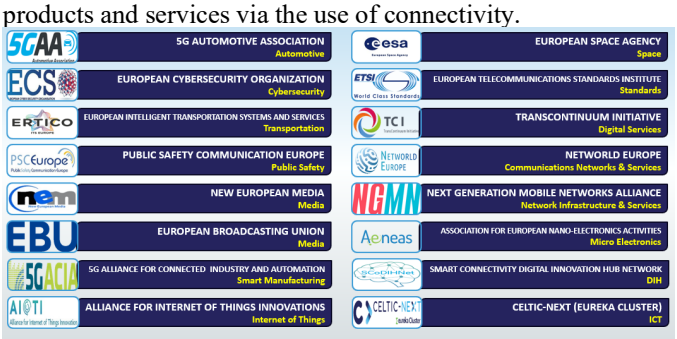

Figure 2: MoUs with vertical sectors, associations, standardization and regulatory bodies.

B. SNS-ICE/6G-IA's approach to consensus building

Globally accepted standards can only be achieved by cooperation, compromise between all relevant stakeholders and competitive contributions. International cooperation requires information exchange and consensus building around new communication technologies and use cases, e.g., from vertical industries. The SNS ICE project acts as an ambassador and provides the platform to communicate and promote the European Vision for 6G networks and the key technological findings of the SNS projects at a global level. Instrumental to this are activities such as an intensive participation in international events, the elaboration of position/white papers and policy briefs, the definition of roadmaps, and collaboration towards the elaboration of joint research programmes. For the last three, this section outlines the main achievements during the first year of SNS-ICE.

a) EU-US Beyond 5G / 6G roadmap

During the fourth Ministerial meeting of the Trade and Technology Council (TTC), which took place in Luleå, Sweden, on 31 May 2023, the EU and US administrations reaffirmed their commitment to cooperate to develop 6G networks. As a first step, the 6G Industry Association (6G-IA), the private member of the EU Smart Networks and Services Joint Undertaking (SNS JU) and the Next-G Alliance requested to provide an interim, joint, aligned 6G industry roadmap by the end of 2023. This document puts forward a comprehensive set of key strategic reflections and recommendations for 6G networks and services, capturing the views and priorities from Next-G Alliance and the SNS JU. It also offers a candidate roadmap for future R&D opportunities through EU and US funding instruments.

Specifically, this document [11] analyses 6 key areas for potential collaborations between the EU and US from 2025 onwards: sustainability of 6G systems, microelectronics and 6G, cloud solutions and distributed computing, open network solutions, artificial intelligence and 6G, and trustworthiness and cybersecurity. In addition, the participating experts (which included SNS-ICE team members from NOKIA, 6G-IA, TNO, and the CTTC) also identified several mechanisms and strategies for cooperation: (i) joint technology Proof-of-Concepts (PoC) targeted towards selected Vertical industries; and (ii) workforce development strategies to increase the number of engineers for the development of advanced 6G technologies. As specific short term actions for the consideration of the policy makers, the document proposes (i) to organize a face-to-face workshop between EU-US in the first quarter of 2024 to discuss the recommendations in the roadmap and potential feedback from the TTC meeting in December, to elaborate on possible actions during 2024; (ii) to create a concrete strategic collaboration agenda in terms of collaborative R&I actions (June 2024); (iii) to organize coordinated Proof-of-Concept towards one or two Vertical Industries; and (iv) to work to identify possibilities for common view on 6G spectrum across EU and US (June 2024).

b) Position paper: Key Strategies for 6G Smart Networks and Services

This document [2] provides a first comprehensive set of key strategic reflections and recommendations for 6G smart networks and services, capturing the views and priorities from

the members of the 6G-IA. The goal is to use this document to further elaborate future versions of the SNS JU Strategic Research and Innovation Agenda (SRIA) as well as the R&I Work Programmes. It also aims to offer directions for collaboration opportunities for European Stakeholders that will go beyond the scope of the SNS JU.

The position paper is organized around two main priorities, namely, 6G Technological Sovereignty which includes components and microelectronics, open SNS solutions, cloudification and distributed computing, network intelligence, security and privacy, and knowledge base; and Sustainability, which captures societal, economic, and environmental aspects. This document provides a brief analysis of each area and proposes concrete recommendations.

The first version of this document was released in September 2023. It should be regarded as a "living document" where topics will be updated or highlighted in the coming years following technological advances, market uptake and ecosystem evolution. Several team members in the SNS-ICE project were directly involved in the elaboration of this position paper, including NOKIA, CTTC, TIM, 6G-IA, and TNO.

c) Collaboration with other world regions in the SNS R&I work programme

Collaboration towards the alignment or definition of joint R&I Work Programmes is of utmost importance for consensus building. The ultimate goal is to achieve unified consensus framework promoting a European approach towards 6G, facilitating international cooperation with other regions having started bold 6G initiatives. The consensus achieved can then be exploited in standardization activities. In the SNS R&I Work Programmes [3], international cooperation targets/has targeted the USA (Call 2023), Japan and the Republic of South Korea (Call 2024). The cooperation with the US focused on technologies and architectures exploring AI to facilitate global validation, adoption and standardization of intelligent approaches; a widely accepted framework for meaningful evaluation of proposed AI/ML-powered solutions for 6G networks; and technology validation in platforms. The collaboration with South Korea targets Radio Access Networks (RAN) and integrated device-network approaches. Specifically, it focuses on (i) AI/ML algorithms for the automation of base station management; base station optimization for energy saving and network failure recovery; and the definition of an architectural framework addressing interoperability needs. As for Japan, the priorities include AI-enabled radio access network (RAN) solutions including physical layer and signal processing technologies, and open RAN/virtualization [3].

The European private side (6G-IA) and the private sides in the target countries have played a very active role in the down-selection of collaboration topics. The public sides, instead, focused on the establishment of links with the relevant ministries/organization and the definition of call conditions.

d) Identification of synergies with microelectronics sector

In the beginning of Q3 2024, a dedicated workshop on micro-electronics workshop was organized in Brussels by the 6G-IA under the auspices of the European Commission and the SNS Joint Undertaking Office. The objective was to stimulate joint/strategic cooperation, notably through structured collaboration between the Chip Act (CA) and the SNS JU. This workshop was supported by key players from both the microelectronics (e.g., AENEAS, Infineon, NXP, ST Microelectronics, IMEC) and the communication/networking (e.g., 6G-IA, Nokia, Ericsson, CTTC; again, including a number of representatives from SNS-ICE) R&I ecosystems in Europe. It counted with first-tier executives and representatives from those organizations. As a top priority for a structured R&D collaboration between the SNS and CA joint undertakings, the following areas were identified: (i) ultra-high transmit power/system gain beyond 100 GHz; (ii) mmWave Radio integration system in a package, heterogeneous integration; (iii) high throughput capacity/fronthaul 100 Gbps digital data path; (iv) joint communications and sensing; (v) new spectrum and associated challenges such as co-existence; and (vi) wide-band amplifiers and integration of several frequency bands.

III. Fine-tuning of SNS messages and contribution to future SNS R&I WPs

This section reports, on one hand, on the approach followed to fine-tune the received information from SNS projects so as to create the global SNS message. On the other hand, it provides suggestions and feedback for possible consideration in upcoming releases of the SNS R&I Work Programme. They stem from the interaction with external key stakeholders via the participation in international events, discussions with funding agencies from other regions, conclusions in policy-related documents, and desk research conducted by SNS-ICE.

A. Fine-tuning of SNS messages: initial steps

The technical work in the Call 1 SNS projects started on January 2023. Therefore, the main messages to convey in this area are mostly related to the scope, work planned to be performed by those projects, challenges being addressed and the expected outcomes. Such information was efficiently gathered by the SNS-OPS CSA (with the contribution of SNS ICE in the formulation of the questionnaire), which created and circulated a questionnaire to all SNS R&I Call 1 projects, as part of the SNS Monitoring & Analysis Framework (SNS OPS Deliverable D1.1 [4]). The questionnaire consisted of three sections, namely (i) technical section, (ii) vision section and (iii) market section. All 33 projects provided their answers in the period April-May 2023. A non-exhaustive list of key insights/messages extracted from the project answers and particularly amenable to be conveyed to an external audience includes the following aspects:

- **Projects will investigate a broad range of technology enablers**. The use of AI/ML and technologies for the orchestration VNFs/CNFs is almost ubiquitous. Other technologies include, but are not limited to, data and network autonomous management (AIaaS), cloud-native networking and RAN-core convergence, mmWave and THz radio technologies, communications and sensing co-design, deep edge-terminal-IoT device integration, integrated satellite hybrid infrastructures, blockchain, new antenna technologies (e.g., RIS), and digital twins.
- **The two main areas/network segments for the application of AI/ML are Radio Access Networks (RAN) and management & orchestration.** Also, several projects plan to use AI/ML at the device level and for security-

related functionalities. Some specific examples of such use include: near-real-time resource allocation, interference management, predictive scheduling, jamming detection and mitigation, network performance prediction (e.g., latency), or beam forming/tracking management.

- **Energy efficiency aspects are mostly addressed at the network/algorithmic levels**. This includes a native implementation of energy-efficiency aspects by design at the architecture level, on the RAN or core/management planes, on the device side, and the design of energy-conscious specific algorithms. On the contrary, the emphasis on energy efficiency at the application or service levels is much lower.
- **Priority KPIs targeted are latency, reliability and energy efficiency**. As a second priority, projects focus on positioning accuracy, connection density, spectrum efficiency, and data rate experienced by the user or network peak data rate.
- **Main contributions to societal challenges: acceleration of the development of advanced network infrastructures and advanced 6G solutions for vertical industries.** Other priorities include the support to research on energy efficiency, the promotion of SME involvement, and technology sovereignty aspects across the value chain.

Concerning the **methodology adopted to fine-tune messages** from SNS projects, it comprises:

- **Interfacing with and collection of information from SNS R&I projects**: This task is performed by the SNS-OPS CSA. via e.g., surveys or direct interaction with the coordinators and technical managers in SNS Steering Board and Technology Board meetings (the latter being chaired by the SNS-ICE Coordinator). Additional links can be established through the chairs of selected SNS or 6G-IA Working Groups or Task Forces, since some of them are SNS-ICE team members too (e.g. Trials WG, Vertical TF). Significant effort and alignment with SNS OPS was required to streamline and minimize requests, so as not to overload the SNS projects, but still be able to acquire vital and necessary information.
- **Alignment with the policies/strategies defined by the 6G-IA**: Those policies and strategies are reflected in a number of position and white papers (e.g., [2]). Such an alignment can be easily guaranteed since several SNS-ICE team members also participate in the 6G-IA Governing Board, lead or contribute to Working Groups, and, further, often act as editors and/or contributors to those documents.
- **Down-selection of the messages to be conveyed**: Since the number of messages that can be effectively conveyed is necessarily limited, a consensus must be reached on the priority ones. This is mostly accomplished by the three SNS-ICE Work Package leaders, who take responsibility for the interaction with international stakeholders, national authorities and vertical sectors, respectively. To that aim, a tight coordination among them is required.
- **Decision on the SNS-ICE team member/means to convey the messages**: Owing to their professional activities and personal background, some SNS-ICE team members are more acquainted with the needs and specificities of some audiences (e.g., academia, decision-makers, national authorities) or are well-known by those constituencies. Further, given their diverse nature, some messages are better conveyed via social media (e.g., LinkedIn or Twitter, for flash news) or via invited speeches, participation in panel discussions, webinars, or podcasts, for more elaborate ones. Decisions on both aspects are made in the monthly plenary meetings of SNS-ICE and reflected in the rolling dissemination plan.
- **Fine tuning of the visual identity, communication style and layout**: Last but not least, in addition to message (i.e. content) fine-tuning, aspects such as an accurate visual identity (so that the 6G-IA can easily be identified as the source for those messages), a professional layout of documents and materials, and an appropriate communication style (e.g., different stakeholders such as companies, academia, or the general audience clearly have different needs) are of utmost importance too. SNS-ICE partners 6G-IA and Trust-IT Services and COMMpla are in charge of the visual identity and the preparation of professional layouts, all synchronised by the SNS-ICE Dissemination manager.

Project deliverable D4.2 [5] provides a detailed account of the communication actions carried out by SNS-ICE partners in the context of (inter)national events. This includes the venues (e.g., 6G World Summit, EU-Taiwan Joint 6G SNS Workshop, EuCNC & 6G Summit, Tokyo 6G Conference, Global 5G & 6G Global Events, Brooklyn 6G Summit) where the aforementioned fine-tuned messages were disseminated.

B. Contribution to the definition of future SNS R&I Work Programmes

At the time of writing these lines, the SNS R&I Work Programme 2024 has just been launched. In the coming months and following the gap analysis of the Call 1- 3 project portfolio, the definition of the Work Programme 2025-26 will begin. The global survey results and insights reported in this SNS-ICE deliverable D1.1 [4], regarding the relevant activities, efforts and focus of other regions of the world, will also act as input towards the Work Programme 2025-26. As an additional input, this section provides some suggestions in [4] for the consideration of the team in charge of drafting the upcoming Work Programme. They follow from the monitoring activity, observations, and lessons learned in the execution of the SNS-ICE project in its first year. More specifically,

- **Continue to fund advanced Trials and Pilots towards 6G under Stream D**: From the co-creation event on Verticals at 5G Techritory Forum, it became apparent that the digitization of vertical infrastructure is a powerful enabler of new or enhanced services, and how nowadays, 5G wireless are creating economic value when comparing EU with other regions in terms of GDP impact. And, also, that the level of investment in pre-commercial Trials and Pilots in other regions is far lower than in the EU. All this would allow the EU to stay one step ahead and, thus, the recommendation.
- **Further boost collaboration with selected regions in the world:** To date, R&D collaborations have focused on three very relevant countries: the US, the Republic of South Korea, and Japan. However, the level of funding has been

limited and the level of integration low (no joint calls, mostly as standalone projects on each side). The aforementioned EU-US Beyond 5G/6G roadmap elaborated in close collaboration with the NextG Alliance [11] calls for *the* creation of a concrete strategic collaboration agenda in terms of collaborative R&I actions, which could be channelled in the upcoming releases of the SNS R&I Work Programme. Likewise, from the EU-Taiwan Joint 6G SNS Workshop in which the 6G-IA participated and other contacts maintained, the potential collaboration with Taiwan seems to be large. This, however, deserves further analysis, given the geopolitical implications this entails. Concerning content definition, valuable insights can be obtained from the participation of SNS-ICE in international and global events (e.g., Tokyo 6G Conference, Global 5G&6G Global Events, or IEEE Future Networks World Forum).

- **Develop lighthouse projects considering policy priorities from the EC and key priorities in the 6G-IA Position Paper**: In the SNS R&I work programme 2024, a Lighthouse project under Stream C will be devoted to strengthening the collaboration with the microelectronics sector. This includes validation/demonstration of the performance of key 6G candidate hardware solutions, technologies, components, and architectures. In the conclusions of the micro-electronics workshop organized in Brussels (see Section II.B, item d), additional priorities for a structured R&D collaboration between the SNS and Chip Act Joint Undertaking were identified. The corresponding SNS and Chip Act Work Programmes could provide a vehicle for such collaborations. The same thing can be said for Photonics 21 with which a number of interactions have been maintained. Besides, upcoming SNS R&I Work programmes should also be in line with the priorities set forth in the 6G-IA Position Paper [2].

IV. Standardization planning and Spectrum Harmonization trends

European contributions and intellectual property rights in advanced 5G and 6G networks are crucial for maintaining competitiveness in the global standards setting. Matching the SNS JU standardisation roadmap with that of Standardisation Organizations (SDO) responsible for setting international standards is an essential step to ensure the interoperability and adoption of the results produced by SNS JU R&I projects.

The SNS ICE project, supported by 6G-IA, aims to facilitate European and international cooperation, promoting research results and informing the community about global trends and national initiatives. In subsequent sections, a comprehensive and detailed approach by the 3GPP, ETSI, and ITU towards developing and standardising 6G is illustrated. While each SDO focuses on different aspects, they share the aim to ensure a robust, innovative, and future-proof mobile communication ecosystem.

A. 3GPP'S Roadmap to 6G

The roadmap of this SDO towards the definition of 6G systems comprises two main phases, namely

- 5G Advanced as a precursor (until 2024): 3GPP Release 18 marks the start of 5G Advanced, building on the 5G baseline defined in earlier releases. This phase includes learning from commercial 5G networks and supporting new market segments and use cases, providing a foundation for future 6G systems.
- Standardisation of 6G system (starting from Release 21): The standardisation of the new 6G system is expected to officially start from 3GPP Release 21. The first 5G Advanced release is set to be completed in early 2024, with the first basic 6G drop anticipated in 2028, followed by subsequent evolution [6].

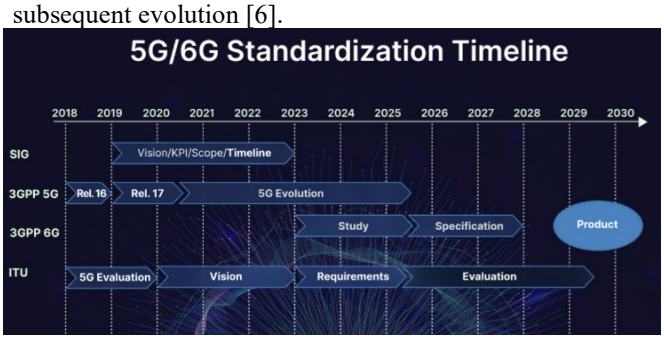

Figure 3: 3GPP/ITU 5G/6G Standardization timeline

B. ITU's IMT-2030 Framework for 6G

In 2023, ITU's Radiocommunication Assembly approved the IMT-2030 Framework, which sets the basis for the development of IMT-2030. This represents the initial phase in the development of 6G at this SDO, which will be followed by.

- Defining Requirements and Evaluation Criteria (2024-2027): The next phase involves defining relevant requirements and evaluation criteria for potential radio interface technologies (RIT) for IMT-2030.
- Supporting Enhanced and New Capabilities (Ongoing): IMT-2030 aims to support enriched and immersive experiences, enhanced ubiquitous coverage, and enable new forms of collaboration. It is expected to support expanded and new usage scenarios compared to IMT-2020, providing enhanced and new capabilities.
- Drafting Recommendations for 6G Development: The draft new Recommendation addresses trends, usage scenarios, and capabilities of IMT-2030, along with considerations for ongoing development. This forms the basis for the standardisation fora to develop the next generation of IMT standards [7].

C. ETSI's work towards 6G

ETSI has recently established a new **ISG addressing Integrated Sensing and Communication (ISAC)** for 6G. ISAC opens the door to innovative use cases like object and intruder detection, fall detection, and environmental monitoring, but also add reliability/trust to localization. The group will define a prioritised set of 6G use cases and sensing types, with a roadmap for their analysis and evaluation. This includes advanced use cases not expected to be covered by 3GPP Release 19, potentially to be included in future 6G releases of 3GPP. They also aim to develop advanced channel models for ISAC use cases and sensing types, validating them via extensive measurement campaigns.

The group also plans to provide outputs for architectures, deployment considerations, key performance indicators (KPIs), and evaluation assumptions. Two studies will be undertaken: one analysing privacy and security aspects associated with sensing data within the ISAC 6G framework and another on the impact of widespread deployment of ISAC on the UN sustainable development goals [8].

In addition, ETSI is currently developing new open-source components within three new groups with active collaboration of several SNS projects, namely:

- **ETSI TFS – TeraFlowSDN** is developing an open-source cloud native SDN Controller enabling smart connectivity services for future networks beyond 5G. EU projects using/contributing code: TeraFlow, ACROSS, FlexScale, Int5gent, SEASON, Hexa-X-II
- **SDG OSL – OpenSlice** is developing an open-source Operations Support System to deliver Network as a Service. EU projects using/contributing code: 5GinFire, 5G-vinni, ACROSS, FIDAL, IMAGINE-B5G
- **SDG OCF – OpenCAPIF** is developing an open-source Common API Framework as defined by 3GPP to enable API exposure and invoke in a secure and consistent manner. EU projects using/contributing code: EVOLVED5G, 6GSANBOX, FIDAL, IMAGINE-B5G.

D. World Radio Conference 2023 - highlights

ITU's World Radio Conference (WRC) is key for the harmonization of frequency allocations. In WRC23, delegates discussed the allocation of additional frequencies to 5G (which, in the long run, could be re-farmed to/shared with 6G) for enhanced coverage and capacity. There is an increasing need to manage the co-existence of IMT with other users as freeing up spectrum for only IMT is becoming very challenging globally. This poses new challenges for technology research on spectrum sharing and reaching consensus in WRC.

For coverage, frequencies below 1 GHz are preferred. Nowadays, however, these frequencies are typically used by broadcasters. In the provisional final acts of WRC resolution 235 [7], UHF (470 - 694MHz) broadcast remains primary in Region 1 (Europe & Russia), but IMT is allowed to use parts of this band on a secondary basis, that is, if it causes no harmful interference. This position will be reviewed in WRC31. As for enhanced capacity, it is declared [7] that the upper 6GHz band (6.125 - 7GHz) can be used for IMT in 60% of the population, but it also establishes that these frequencies are used for WiFi6. No details are given on how co-existence should be managed.

There was also a resolution for global harmonization of the 3.5GHz band, the main capacity layer and the pioneer band of 5G. The harmonization of the 3.3-3.8 GHz band in Europe, the Middle East and the Americas will clearly benefit 5G services in those regions. Studies on globally harmonized bands for 6G are deferred to WRC27. Notably, the study of harmonized 4-15GHz bands is a key topic resolution [7]. Complementarily, sub-Terahertz bands bring about larger contiguous blocks of spectrum for ultra-low latency and very high bit-rate applications of IMT [7]. Higher frequency ranges, namely, 102-109.5, 151.5-164, 209-226, and 252-275 GHz, are identified for studies in WRC31.

Finally, the definition of a direct-to-device mobile satellite study also plays an important role, as it may provide a number of societal benefits: narrowing the digital divide for people and activities living at the edge of cellular coverage, provision of 3D connectivity for UAVs during flight in many areas of the world, etc. Allocation of (existing) harmonized IMT frequencies and standardization should enable more affordable mobile satellite services and make it convenient for people to use a single smartphone or IoT device.

V. Conclusions and Way Forward

The work presented in this paper provides an overview of the SNS JU international collaboration ecosystem, key strategies, main work directions and roadmap, as recorded by the activities of the SNS ICE project. Additionally, an analysis of the status of the relevant SDOs and their respective roadmaps was presented, highlighting the alignment with the SNS JU and broader ecosystem activities. Via the tight monitoring and reporting of global 6G activities, the engagement with multiple international stakeholders and relevant standards work, and the dissemination of SNS work towards targeted events and communities, the SNS ICE project helps position the SNS JU in the global 6G landscape and ensures that the voice of the EU R&I community is heard. As the SNS JU activities will pick up pace with Phase 2 and Phase 3 projects in the coming months, SNS ICE's role as the main interface between SNS JU and the world will become even more critical, and further analysis and alignment activities will be required, to facilitate the SNS JU community's target to contribute towards the creation of a single global 6G standard.

Acknowledgment

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