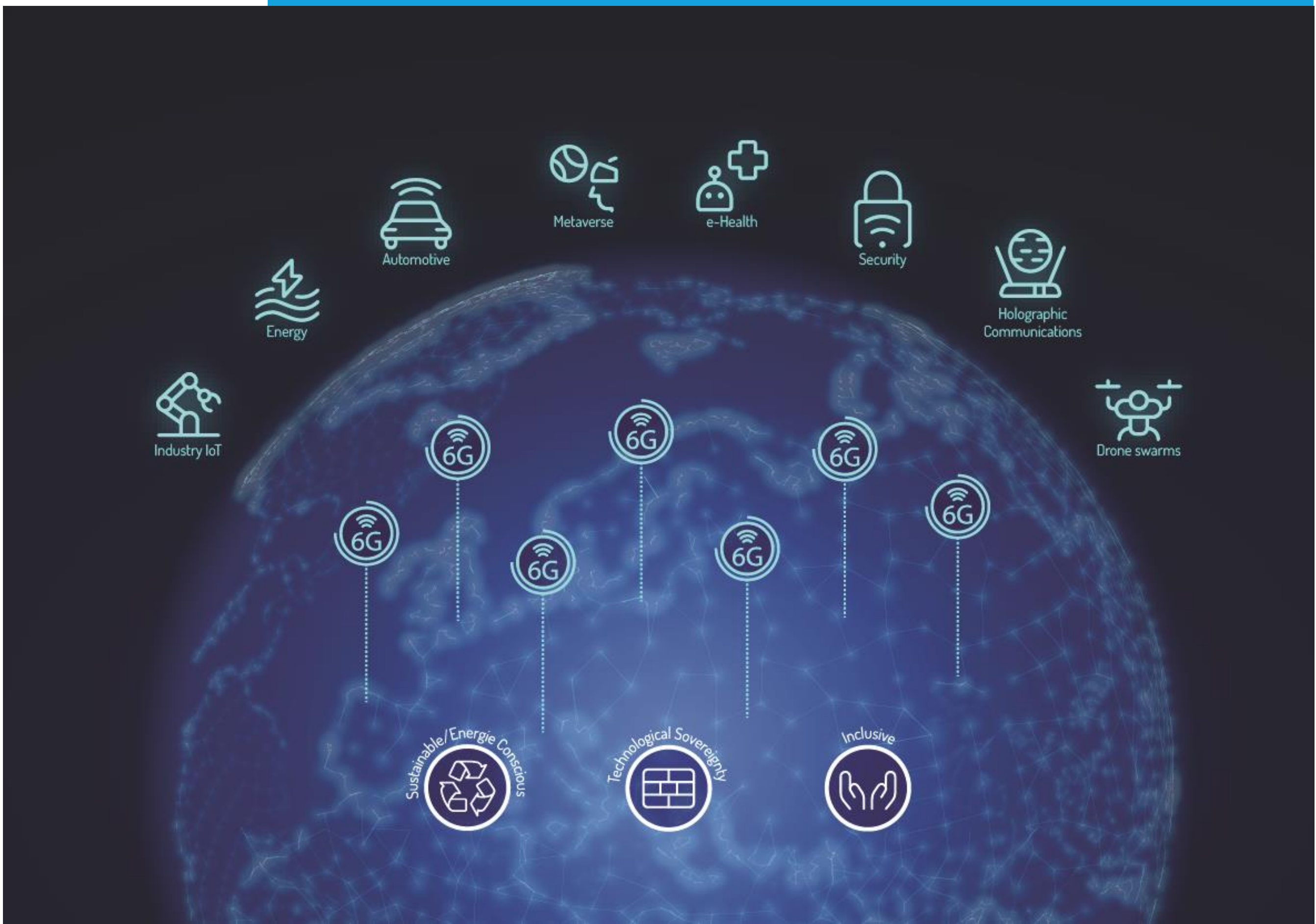
6G Smart Networks and Services Industry Association (6G-IA)



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Final expert report - Approved by the 6G-IA Board

Position paper

RESEARCH PRIORITIES

NON TERRESTRIAL NETWORKS (NTN) IN 6G

Editor: Bernard Barani

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1. INTRODUCTION AND CONTEXT

The early calls of the Smart Networks and Services Joint Undertaking (SNS JU) have delivered a number of projects that are directly related to Non-Terrestrial Networks (NTN) and addressing the Beyond 5G and 6G context. These projects cover both architectural issues with multi orbit constellations being at the centre of R&I on the matter and specific technological issues such as D2D, waveforms, AI integration, software defined systems...

They follow the now established trend of the satcom industry to join the 3GPP ecosystem which is expected to address weaknesses of the satcom ecosystem, notably volume and interoperability. In that context, expected benefits from 5G/6G NTN to sat industry are expected to be: i) integrate a mainstream technological set and architecture with CN, gNB...; ii) commercial change, e.g. access to mass markets like cars; iii) new optimized cross domain operations; iv) innovation, with need of test labs/experiments for a more proactive approach towards a diversity of technologies and use cases. The running activities are also in line with the unification concept of satcoms, i.e. beyond integration, which requires the satellite systems to use insofar as possible the same technologies and architectures as those developed for terrestrial systems.

In the context of the SNS JU, and also in other regions of the world, NTN is considered as an integral component of future 6G systems which is also needed to address specific 6G requirements such as coverage, versatility, specific public use cases, and to contribute to UN Sustainability objectives. To focus SNS work on the matter, the 6G Smart Networks and Services Industry Association (6G-IA), representing the private side of the SNS JU, initiated a number of workshops and consultations as of early 2024 to:

i) Take stock of the key industrial directions framing NTN developments in Europe and outline related R&I in NTN at EU level, notably the essential work addressed by ESA and other European space agencies, with the objective of optimizing synergies;

ii) identify NTN and use cases components of high priority for 6G where the terrestrial and satellite industries could define joint focused industrial actions to frame future promising investments.

This work has been open to ESA, Space Agencies, SNS JU office representatives and to DG Connect relevant services. It has been subject of multiple contributions that led to the identification of key 6G use cases and architectures driving NTN R&I. Eventually, 9 space specific technologies have been identified, complemented with 8 technological topics of high priority addressing the seamless integration of satellite systems into the wider 6G architecture, both from the perspective of a unified/seamless end to end control and management of resources and of an end to end seamless user plane.

This work, including a roadmap for implementation, has been subject of a comprehensive report finalized early 2024[1]. The proposed roadmap (see annex 1 of the report) covers several years (i.e., several R&I Work Programmes) in view of mobilizing critical mass resources over time. This roadmap has been used to agree with the stakeholders at large the NTN action[2] currently open under the SNS JU Work Programme 2025 call with submission date on 18 September 2025. It focuses on a subset of the 8 technological topics of high priority addressing the seamless integration of satellite systems into the wider 6G architecture, the remaining part having been left to subsequent work programmes as appropriate.

2. SETTING THE SCENE

The NTN project to be implemented in the context of the SNS JU for an amount of € 8 million under WP2025 is expected to be selected by the end of the year for a start in Q1 or Q2 2026[3]. In the meantime, many developments have taken place in the NTN domain.

First, the set of technologies identified in the previous 6G-IA report is considered as still valid and may be taken as a basis to progress towards implementation of experimental and eventual commercial systems;

Second, 3GPP is progressing on standardization of the NTN component for B5G, paving the way towards 6G. Two tracks are being investigated at 3GPP level: NTN-NR and NTN-IoT. The first one corresponds to broadband services delivered by satellites, including direct to device (D2D) capabilities; the second to NB-IoT services. Since the starting point at Release 17, the main issues addressed by 3GPP are as follows:

Release 17	**Release 18**	**Release 19 (on going)**
Support GEO & NGSO GNSS capable UE Transparent Payload Support of 5GC Mobility Management S and L Band Definition	IL coverage enhancement Deployment above 10 GHz (Ka band) Mobility and Service continuity Network verified UE location Fixed VSAT for GSO/NGSO Mobile VSAT for GSO L/S Band	Regenerative Payload DL Coverage enhancement UL Capacity throughput enhancement Cell broadcast LTE to NR-NTN mobility Mob VSAT for NGSO Higher Tx power UE in FR1 Ext L, S, Ku bands

3GPP NTN-NR Work Items

[1] Research Priorities on Non Terrestrial Networks (NTN), https://6g-ia.eu/wp-content/uploads/2024/05/f2f-wkshp-ntn-report-vf-formatted.pdf

[2] See page 21 of: https://smart-networks.europa.eu/wp-content/uploads/2024/12/sns-ju-ri-wp-2025_final-publication.pdf

[3] HORIZON-JU-SNS-2025-STREAM-B-05: Microelectronic – Front-End Module (FEM), Page 28 of: https://smart-networks.europa.eu/wp-content/uploads/2024/12/sns-ju-ri-wp-2025_final-publication.pdf

Release 17	Release 18	Release 19 (on going)
Support GEO & NGSO with GNSS capable UE Transparent Payload Support of EPC Only Discontinuous coverage Mobility Management FR1 Band	Mobility procedures HARQ disabling Discontinuous coverage L/S Band, extended L band In Band IoT using in band and guard band in NR channel	U/L capacity enhancement Store and Forward operation Cell broadcast for PWS Higher Tx power in FR1 band S band extension

3GPP NTN-IoT Work Items

These are the capabilities that are being addressed now. There are still multiple issues to sort out though. In the specific context of 6G, the two workshops organized by 3GPP have led to an identification of requirements by the satcom industry to serve 3 different markets: consumer market, enterprise market, vertical markets[4].

Third, industry has progressed beyond R&I towards prototyping and experimentation. Notable European examples include the demonstration by Eutelsat supported by Mediatek of the applicability of the 5G-NR waveform to a LEO constellation like OneWeb, the implementation of experimentation space capabilities by ESA e.g. MIXELS testing several RAN splits between terrestrial and ground components and using small cubesats, and 6G LINO fully regenerative space payload testing full gNB and on-board edge capabilities embarked on cubesats. At SNS level, the 6G Sandbox project is testing various NTN integration scenarios with private 5G cores and has signed a MoU with ESA to access their experimental platform.

Fourth, industry is announcing plans to move some applications already in the commercial domains. In that respect, one may note the recent announcement by AST Space Mobile to create a jointly owned satellite operator with European Telco Vodafone for direct-to-smartphone services. Several industry initiatives have also been announced to serve D2D market, following up on similar announcements by SpaceX, Globalstar, Telesat with access to spectrum becoming a critical issue as recently shown by the Starlink move to access Echostar spectrum with a deal of $17 billions. It may however be noted that most of these initiatives can not be considered compliant with 3GPP NTN (Rel 17 and beyond) solutions and adopt proprietary solutions. In the NTN-IoT domain, the European Seteliot initiative is based on 3GPP Rel 17 NB-IoT with an NTN constellation in LEO and relies on the Store & Forward option of Rel 19 for low density constellation.

Against this background, 6G-IA organized on 16 May 2025, a follow-up workshop with representatives of ESA, of the SNS Jus office, of the relevant services of DG Connect, and with a panel of key players from industry and research centers/academia of the Telecom and satcom domains. The agenda and contributors to the workshop can be found in Annex 2.

[4] See e.g. 3GPP SA1 Jeju Workshop: S1-241041

The purpose of this workshop was to help 6G-IA to define R&I proposals for future R&I Work Programme, and to identify the key complementary actions taking into account industrial developments and Space Agencies plans. Considering the developments in the NTN domain, a key question was the relevance of moving beyond pure R&I in future SNS calls, and to target Stream D type of activities, i.e. experimental actions with direct involvement of verticals. The following issues were discussed:

2.1. INSTITUTIONAL SESSION

The DG Connect E1 representative supported by the SNS office recalled the high EC interest for NTN and the running projects in the field. These projects are reported to address in priority: Fully integrated TN/NTN network architecture with regenerative space nodes; Software defined payload, on-board processing and storage capabilities, Space Edge Computing; Dynamic orchestration of VNF in 3D networks; Optimal resource allocation across 6G 3D network supported by ML/AI techniques; Analysis of use case's needs. The stated objective is to support Europe to become a lead player in NTN provision. For the future, experimental facilities and demonstrations are considered as important and part of EC/SNSO thinking. It is also recalled that the overall strategy should address the ground segment and possibly microelectronics/chipsets for NTN. Cooperation with ESA is seen as adding high value to SNS actions.

ESA made an extensive presentation on existing industrial initiatives, NTN requirements towards 6G and pointed at the NTN Forum they initiated, see https://connectivity.esa.int/the-non-terrestrial-networks-forum -note that ESA collaborates as well with GSMA NTN group and commonly launch the ESA-GSMA challenges for development/protoyping of technology enablers addressing specific TN/NTN interoperability issues. A particular focus of the ESA actions relates to space experimental facilities and the proposal for 6G OpenLab that is currently being under discussion. It targets holistic technology demo capabilities and includes availability of in orbit capabilities through the 6G LINO, MIXELS programmes expected to be implemented early 2026 and their evolutions. Besides. The 6G Open Lab is expected to be a federating initiative contributed by stakeholders at large including satcom vendors, satcom operators, terrestrial mobile equipment vendors and operators, R&I institutes, measurement and test equipment vendors, chipsets manufacturers. It is open to non-European companies (e.g. Mediatek, Qualcomm, Samsung.). Similar initiatives of National space agencies, such as StarLab experimental payload is expected to be launched for Q4 2025 that would augment space experimentation capabilities.

The discussion showed the interest to have such demo capabilities developed to support NTN technological and system experiments in Europe. Key features include 2 tracks:

i) To test integration and interoperability with terrestrial 6G R&D networks and equipment development
ii) To test key technologies for satellite in 6G networks, including:
   a. TN/NTN Handover capabilities and control plane integration
   b. Joint orchestration of integrated TN/NTN services
   c. AI-assisted dynamic spectrum allocation and service-based resource management
   d. Self-optimised air interface
   e. Sub-THz transmission
   f. Neuromorphic processors
   g. Cognitive radios

ESA offered to take advantage of the experimentation facilities within the SNS programme and to incentivize NTN projects to link with these platforms. In the meantime, ESA has also signed Memorandum of Intent to offer such experimental facilities to SNS projects.

In conclusion of this part, and taking into account the timing of future SNS calls which was not known at the time of the workshop, (possible NTN specific call not before WP 2027) it is suggested to organize a stock taking workshop with ESA early 2026 to:

- Outline the access conditions of the infra (e.g. IPR, legal rules)
- Outline the set of services that may be provided to interested SNS consortia,
- Outline the development status of the 6G Open Lab initiative, and the timing for experimental infrastructure aspects.

2.2. INDUSTRY & RESEARCH BODIES SESSION

2.2.1. FRAMING SNS R&I BOUNDARIES & PRIORITIES

Industry and R&I stakeholders outlined their views in relation to future research and experimental activities that should be addressed beyond currently running activities. These follow two main classes of requirements, in the wake of the 3GPP methodology:

i) Improved user experience through:
- **Improved service continuity** over the coverage requiring enhanced NTN/TN mobility/multi connectivity especially in connected mode
- **Improved coverage** with provision of emergency services (at least SMS) via satellite in light indoor/in vehicle conditions, of mobility in sub-urban/dense forest (i.e. several hundred ms fading duration)
- **Support of device diversity, including h**andheld/IoT, vehicle/drone mounted
- **Improved data rate/throughput**, pushing for TN waveform compatibility and harmonisation

ii) **Improved service network capabilities through:**

- **Resilience,** with GNSS independent operation (i.e. initial access, ..), GNSS independent capability for the UE to determine its location, service continuity under temporary failure of a given node (e.g. NGSO, GSO, HAPS, TN node), Fast set-up of an autonomous network over a specific region via satellite(s) and/or HAPS with no or intermittent connectivity to core networks (e.g. for crisis response)
- **Sustainability:** with minimization of overall energy/resource consumption implying energy-based access network selection: under traffic or zero traffic conditions (dedicated management functions needed)
- **Overall spectrum usage efficiency, with multi access technology spectrum coexistence (i.e. NTN/TN)**

In terms of KPI, the below table was progressed as a possible reference set of indicators when moving towards 6G:

Target Service Performances	NTN in 5G (As per 3GPP &/or ITU-R IMT2020 satellite requirements)	NTN in 6G
Peak data rate (DL/UL) wrt Handheld & low cost IoT devices	1/0.1 Mbps (Outdoor only) @ up to 3 km/h	Outdoor conditions: Tens of Mbps @ up to 250 km/h Light indoor/in car conditions: At least Short Message Service capability
Peak data rate (DL/UL) wrt Vehicle or drone (flying and surface) mounted devices	[50/25] Mbps @ up to 250 km/h (with 60 cm aperture)	Hundreds of Mbps (Outdoor only) @ up to 250 km/h (with
Peak data rate (DL/UL) wrt Large Aeronautic, maritime platforms mounted devices	[50/25] Mbps @ up to 1000 km/h	Thousands of Mbps (Outdoor only) @ up to 1200 km/h (with
Location service (target accuracy and acquisition time) in outdoor conditions only	respectively 1 meter and < 100 seconds (reliability through Network verification)	respectively 1 meter and < few seconds (95% reliability through Network based positioning method)
Coverage	Outdoor only	Light indoor/In car
Reliability	up to 99.9% (1-10−3)	up to 99.999% (1-10−5)
Over the air Latency for eMBB-s and uRLLC-s	Control plane: 40 ms User plane: 10 ms	Control plane (propagation delay excluded): same as IMT-2030 terrestrial Radio Interface User plane (propagation delay excluded): same as IMT-2030 terrestrial Radio Interface
Connection density	Up to 500 per km2	>1000 per km2

Reference: Non-terrestrial Network (NTN) in 6G, 6G-ntn.eu

From the above requirements, it was outlined that a number of those may already be covered to an extent with running projects or the project to be implemented under SNS WP 2025, resilience and security being quoted as the least well addressed today. In that respect, it was commented that the **2025 call mainly focuses on upper layers and management as follows**[5]:

- **Topic 1:** Management of multiple access networks through unified Control
- **Topic 2:** Dynamic routing in multi-dimensional networks & reference multi orbit constellation

[5] Topics refer to the priority topics as identified in the 6G-IA NTN report of 2024

- **Topic 4:** Spectrum issues
- **Topic 5:** Multi tenancy and end to end resource slicing capabilities

This led several speakers to call for more coverage on pure layer 1 issues, such as: MIMO from space and impact on NR standards (e.g. to support beam hoping), antenna design; coverage of higher bands (Q/V bands); Free Space Optics to cover ISL of feeder links; satellite swarms and creation of large array antennas; UE array terminal.

Whilst it is recognized that these issues are highly relevant for NTN performances, 6G-IA position is that these issues are pure satellite issues that they are best served by space agency programmes. The current 6G-IA position is rather to look into technological issues that can support full integration/unification of the satellite and terrestrial networks, including seamless service provisions. On the other hand, it is recognized that some topics of the 2024 report identified for beyond 2025 programme and defined as:

Topic 6: integrated sensing/ positioning and communications

Topic 7: multiaccess

they may be related to layer 1 R&I. in that context, these issues should be addressed under SNS from a system perspective and not as detailed R&I on aspects such as antenna or satellite design.

This issue may be further discussed with stakeholders at the time of developing the eventual text for WP 2026 covering NTN.

2.2.2. SNS R&I PRIORITY TOPICS

In general, all session participants, from both industry and research sides, reconfirmed their support to the topics identified for implementation in future SNS WP's as identified in the 6G-IA NTN report of 2024. These cover:

Topic 3-AI Based end to end resource control, orchestration and management, with seamless TN-NTN resource management capabilities, covering rapid reconfiguration for emergency/disaster situations. On this topic, it is indicated that important issues include: i) AI-based resource control with TN-NTN interactions such as handover, traffic offloading and pre-emptive radio resource control; ii) ground-space AI models life-cycle optimization and determination of the space segment requirements in terms of storage and inference considering the distributed fashion of the computational resources, i.e. architectural implications of AI for the resources of the NTN constellation; iii) optimized network selection. At system architectural level, it may also be relevant to explore architectural aspects towards a neutral network operator exploiting NTN and TN segments in a transparent way to verticals and users, reusing/defining APIS and interfaces to MNOS and SNOs.

Topic 6-Integrated communication and positioning, GNSS free operations, study of various architectures (Network, UE, multiple satellites, etc.); integrated communication and sensing. GNSS free operation is seen as particularly important to address lack of 100% availability of GNSS signals and potential security/resilience implications. Multiple architectures (terminal or satellite driven) may be considered. Impact of low power constrained IoT devices should be taken into account, as wells as the limitation of the current (Rel-18 defined) network verified UE location scheme which may not be able to determine reliably the UE location with an accuracy of few kms with large beam size (including regulatory related issues when a serving beam area crosses national boundaries). On this topic, it is important to make a clear distinction of location information usage, i.e. for user service or for operations.

Topic 7-Multi access capabilities and carrier aggregation. This should be addressed in view of providing broadband connectivity with high reliability via satellite access operating in high frequency bands characterized by low radio link availability. It is also indicated that Multi Access should consider the impact on Topic 2 (dynamic routing), as Multi access capabilities (part of topic 7) implies Multi PDU sessions to support several flows with Multipath transport protocols embedded in the UE with the network providing integrated solutions in current 3GPP and non-3GPP TN networks, including current NTN as backhaul. However current 3GPP transport solutions for muti-connectivity like MPTCP, and MPQUIC may not directly work in the high dynamic NTN+TN context

Topic 8-Autonomous and self-configuration of NTN resources and stability vis a vis TN resource management and control. It is indicated that this is important for fast set up of networks at the edge, i.e. without CN connectivity in specific cases such as crisis management. It is also proposed to extend the autonomous notion multi layered NTN networks (drones, aircrafts) and to address convergence with other networks (earth observation) coupled with semantic communications for specific safety critical use cases.

Beyond these aspects related to the 2024 NTN roadmap, the following aspects were identified as important:

- Security aspects are not addressed in the current roadmap. It is needed to address at architectural level post quantum cryptography issues as outlined in the document "Securing Tomorrow, Today: Transitioning to Post Quantum Cryptography" (a joint statement from partners from 18 EU member states) to deploy post quantum cryptography (PQC) in hybrid solutions for most use cases, i.e. combining a deployed cryptographic scheme with PQC. This issue may though be much wider than NTN issues and may be addressed in the context of other SNS related security actions;
- RAN issues: in addition to topics 6 and 7 outlined above which have direct relation with RAN architectures, it is indicated that technological work is still needed to address specific NTN RAN requirements, notably:

  - Flexible RAN functional split. There is no optimal split for all use cases and optimization is use case dependent. This requires availing from flexible programmable implementations. NB: this is currently part of number of ESA developments/prototypes;
  - Coverage extension, to multiplicity of use cases, such as light indoor or automotive, with minimized constraints on board resources;
  - Unification of 5G NR standard, taking into account NTN requirements such as loss of signals orthogonality due to variable doppler and distance from UE to satellite;
  - Grant free access to support large number of IoT terminals;
  - Co-existence of standards (4G IoT, 5G, 6G) in the same beam for migration and backwards compatibility aspects
  - Diversity of user terminals and flexible radio link optimization as a function of UE capabilities including PAPR issues.
- A particular RAN issue between TN and NTN relates to the access mode. TN has been developed with TDD access mode and the industry has developed a terminal ecosystem that is based on TDD access. NTN is standardized with FDD mode of access, which has no traction in terms of large ecosystem at the moment. If it the FDD mode does not take up, it may be relevant for NTN to address a modified TDD access, which creates specific issues related notably to the spread of RTT's (round trip delays) experienced by the set of UE's served under by one single satellite. Further integration and unification would in fact benefit from a TDD based NTN ecosystem that is not here today.

2.2.3. USE CASE ASPECTS

The maturity of verticals and of related use cases was part of the questions addressed at the workshop. However, the discussion did not allow to go much beyond the use cases identified at the 2024 workshop. At this time, the conclusion was that the focus could be on specific use cases involved in the 6G domain and making particular use of the 3D dimension of 6G. Considering the efforts currently dedicated to the automotive domain and the limited resources available, it was suggested that SNS could address in priority the aeronautic domain (unified comms for passengers, cockpit and ATM) and the FRMCS domain, with possible room for complementary use cases (e.g. automotive for specific issues). These two domains were recalled as important by the workshop participants, with two additional considerations: i) for the aeronautic domain, the approach should be to target a single unified system for cabin and cockpit communications, two domains that have so far requested different independent systems. Involvement of the Seamless Air Alliance (SAA) would be critical for the success and take up of R&I activities in this domain; ii) For the railways systems, FRMCS would be the obvious target, in the wake of the cooperation work already started between the SNS and EU-Rail JU's.

Two other domains were mentioned, though less prominently: i) PPDR use case, piggybacking on the EUCCS initiative and moving it beyond the 4G focused architecture it is currently developed with; ii) emergency/governmental services piggybacking on IRIS² developments. These two use cases could also be an opportunity to further develop D2D technologies and services, eventually benefiting from a challenging broadband D2D option or from very advanced technologies like semantic communications. These aspects appear though not to offer a very high maturity level to go into vertical experiments.

It may be noted that these use cases are of particular interest as the satellite option is basically the only one that can offer the needed service characteristics.

2.2.4. EXPERIMENTAL ASPECTS

One of the key questions the workshop had to address was the relevance of launching Stream D (6G experiments for vertical use cases) in future SNS calls. For vertical companies to be interested to join experimental projects, it is important to avail from a demonstration infrastructure that may be representative enough from a quasi-operational NTN/TN system.

The workshop confirmed that there are in Europe a multiplicity of infrastructures available for test and demos. This relates notably to software/programmable core networks, RAN equipment with multiple cell sites operating at different frequencies, programmable terminals with software implementations (Amarisoft). There are also some gateway space connectivity equipment available. A number of experiments have also already started, such as the Mixels project of ESA that is testing with several cubesats provided by Canada the possible access splits between RAN and core functionalities. Other experiments have started with the REMI experimental platform developed by ESA. Other experimental platforms have made possible to test TN/NTN handovers, also with terrestrial emulators.

The real constraint comes from the space segment, with only few cubesat simple satellites available, the ESA initiative (6G LINO extension) eventually targeting availability of 6 satellites that may be representative of a small constellation, though this may be a limitation considering that some advanced technological features (e.g. in space routing) may require availability of a full constellation. As it may not be sustainable either to deploy a constellation to experiment on routing, the need to develop advanced NTN digital twinning systems that can permit larger scale experimentation may be considered.

Also, there is no possibility to have available in the medium/short term regenerative programmable payloads for the space segment. On the GEO side, the situation is somewhat better as there are multiple Geo operational EU satellites that could be used for experiments, but they are not fully representative of a comprehensive NTN system. Therefore, two positions emerged at the workshop[6] for what concerns experimental activities:

- Piggyback on available (or soon to be available) "simple" cubesat satellites to test innovative NTN capabilities to be developed, such as the demonstration of TN-NTN connectivity and seamless handover for e.g., railway scenarios, including cross border roaming. This could be an extension of the ESA 6G LINO, Mixels demonstration concepts involving verticals to demonstrate on top of the innovative TN/NTN infrastructure consumer services such as infotainment and vertical management services;
- Target a full ambitious programme including a multi satellite constellation with all innovative features such as regenerative payload, terminals, ISL's that may eventually be the basis of a comprehensive programme of demo targeting a multiplicity of verticals. This may though be seen as a long-term option.

3. CONCLUSION AND WAY FORWARD

Two main messages emerged at the meeting: i) the original SNS NTN roadmap as identified in 2024 is still largely valid, though requiring some adaptation and priority setting, also taking into account the results of the WP 2025 call and related industrial developments; ii) moving into a more experimental approach is widely supported, but the main issue relates to the space based infrastructure that may be available to that end in the context of WP 2027. Hence the discussions that took place at the workshop indicated that 3 main options may be considered (with some variations) for the next SNS work programme. It takes into account the fact that the WP 2026 can only be a "light" programme and that the main opportunity for a sizeable NTN initiative under SNS can only be under WP 2027, which was not known at the time of the workshop:

- Focus mainly on residual though important R&I aspects, as outlined under Topics 3, 6, 7 and 8 above. Considering the very low coverage and the still low TRL level of the issue, topic 8 on autonomous and secure/resilient networks would be a very high priority among these topics;
- Focus SNS on an experimental initiative, using Cubesat like infrastructure, programmable features and demonstrating some of the key features of an NTN integration with a TN infrastructure. Topics 1, 2, 4, 5 of the roadmap, which are subject of the open call, could be taken as mature enough topics and technologies to move into the experimental domain, beyond a PoC perspective; This would correspond to a "Stream C" type of programme;

[6] NB : post workshop consideration also suggested that NTN Digital Twins may also be a solution

- Complement the experimental initiative with specific vertical demos, with a priority for use cases where satellite is the only option. This would correspond to a Stream D activity that could address a few use cases, as has been done up to now.

Regarding a comprehensive programme with a large-scale demonstration capability of a full system beyond the use of cubesat, this could be subject of an exploratory CSA in view of FP10.

The above options critically depend on the level of technological maturity of critical NTN features and of availability of in orbit capabilities, even if reduced compared to a full constellation. Therefore, it is proposed to hold a complementary "convergence" focused workshop early 2026 at a moment when:

- The NTN project selected under WP 2025 of the SNS programme will be known.
- The ESA availability of in orbit capabilities may be more detailed.

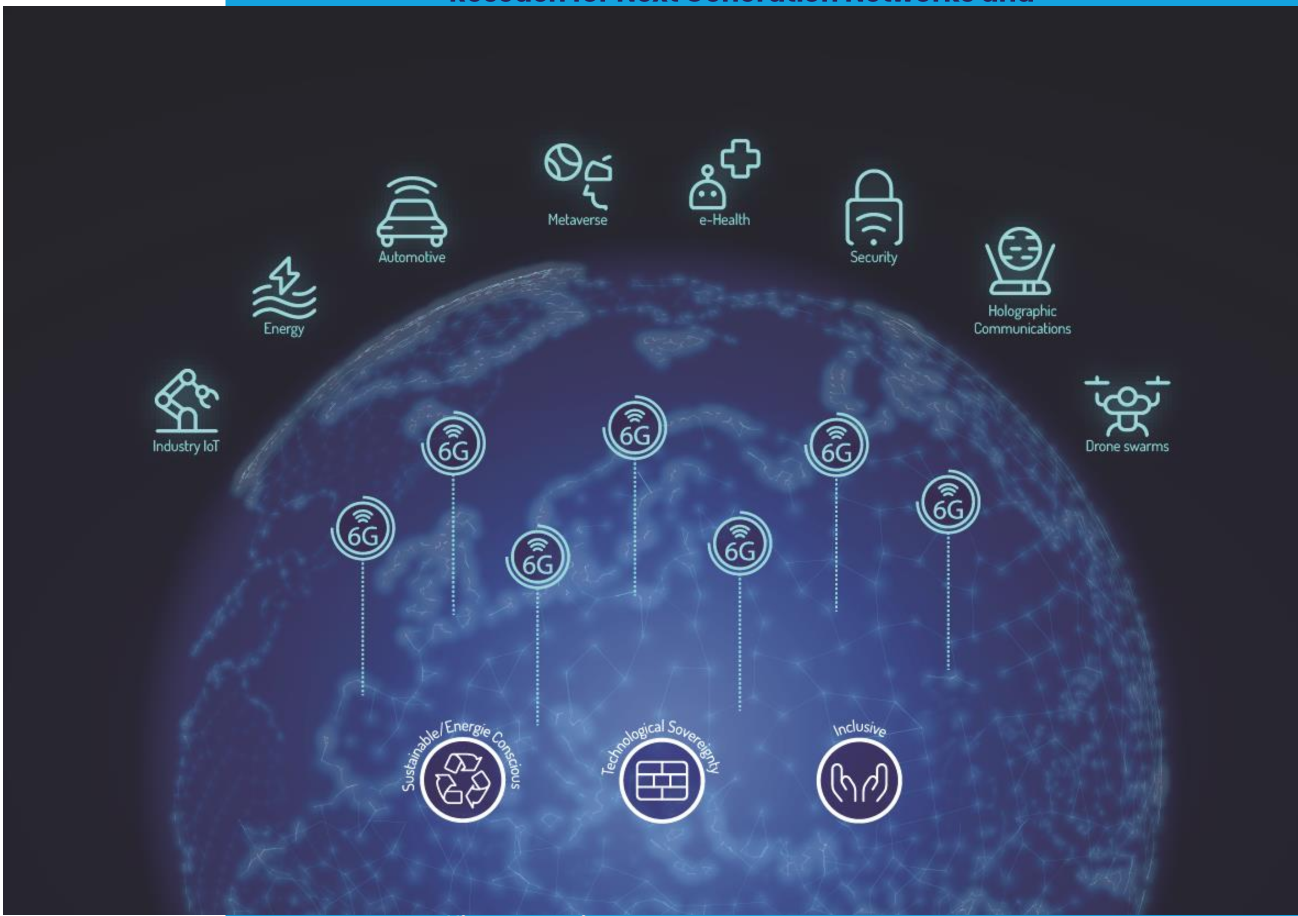
ANNEX 1. ORIGINAL ROADMAP FOR NTN WORK UNDER SNS

	WP 2025	WP 2026	WP 2027
SNS WP	Topics 1, 2, 4, 5 to cover in priority. The proposed projects targets unification/integration where unification not possible of TN and NTN with focus on dynamic routing and protocols, integrated Control plane serving both TN and NTN with RAN management, spectrum co-existence, and orchestration of resources towards Multi tenancy. Topic 6 on integration com/sensing may also be considered.	Topics 3, 6, 7, 8. To cover complementary issues, including positioning and sensing capabilities, AI assisted E2E resource management, multi access capability enhancement and autonomous self configuring NTN resource with TN interfacing.	-Dedicated complement for demonstration of specific technologies, e.g. multi segment handover, E2E slicing, RAN adaptation.. -Focused Use Case project, tentatively addressing aeronautic and/or FRMCS usages with possible complement in other Use cases.
Synchro	Light Synchro and information exchange through structured SNS/ESA framework	Light Synchro and information exchange through structured SNS/ESA framework	Reuse where applicable ESA or national agencies satcom resources for low-cost space segment (cube sat type)

ANNEX 2. AGENDA AND SPEAKERS, CONTRIBUTORS

Time slot	Topic	Speakers
10:00 – 10:10	Welcome & Introduction	**6G-IA:** Bernard Barani, Alex Kaloxylos
10:10 – 10:45	Institutional plans and expectations	**SNS Office:** Cristina Cullell March **EC Unit E1 :** Enrique Gomez **ESA :** Maria Guta, Xavier Lobao
10:45 – 12:30	Industry views	**TAS :** Nicolas Chuberre, Flavien Ronteix Jacquet **Airbus :** Amina Boubendir, Oriol Vidal, Xavier Pons **Qualcomm:** Juan Bucheli **Nokia:** Jeroen Wigard **Sateliot:** Sergio Aguilar
	Lunch break	
13:15-15:00	R&I centers views	**I2CAT:** Joan A. Ruiz-de-Azua **CTTC**: Xavier Artiga **DLR:** Sandro Scalise, Tomaso De Cola **University of Bologna** : Alessandro Vanelli Coralli **Fraunhofer HHI :** Thomas Haustein **University of Malaga :** Pedro Merino **University of Surrey:** Michael Fitch
15:00 – 16:30 (max)	Discussion and conclusions, Future SNS priority setting for NTN	All

6G-IA is the voice of European Industry and Reseach for Next Generation Networks and



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