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D6.3 – FINAL REPORT OF DISSEMINATION, EXPLOITATION AND COMMUNICATION ACTIVITIES

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V1.0	29/08/2025	Frank Burkhardt	Submitted version

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ABBREVIATIONS

Abbreviation	Explanation
3GPP	3rd Generation Partnership Project
5G-ACIA	5G Alliance for Connected Industries and Automation
5GAA	5G Automobile Association
6G-IA	6G Industrial Association
6G SNS	6G Smart Networks and Services
AAU	AALBORG UNIVERSITET
AI	Artificial Intelligence
Apple	Apple Technology Engineering B.V. & Co. KG
ALLR	approximated logarithmic likelihood ratio
AWPC	Topical Conference on Antennas and Propagation in Wireless Communications
BOSCH	ROBERT BOSCH GMBH
CENTRIC	THE USER-CENTRIC AI-AIR INTERFACE (AI-AI)
CNIT	CONSORZIO NAZIONALE INTERUNIVERSITARIO PER LE TELECOMUNICAZIONI
COGNIN	COGNITIVE INNOVATIONS PRIVATE COMPANY
COST	European Cooperation in Science and Technology
CPN	Computing Power Network
CN	Core Network
CSCN	Conference on Standards for Communications and Networking
DL	Downlink
EC	European Commission
EM	Electronic Module
ETSI	European Telecommunications Standards Institute
ESoA	European School of Antennas and Propagation
ETFA	Emerging Technologies and Factory Automation
EUCAP	European Conference on Antennas and Propagation
EuCNC	European Conference on Networks and Communications
eURLLC	Extreme Ultra Reliable Low Latency Communication
FHG	FRAUNHOFER GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG EV
ICC	International Chamber of Commerce
ICEAA	International Conference on Electromagnetics in Advanced Applications
ICNC	International Conference on Computing, Networking and Communications
IDE	INTERDIGITAL EUROPE LTD
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IMEC	INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM
IMT	International Mobile Telecommunications
IPR	Intellectual Property Rights
ISAC	Integrated Sensing and Communication
ISG	Industry Specification Group

ISCC	IEEE Symposium on Computers and Communications
ITU	International Telecommunication Union
JU	Joint undertaking
Keysight	Keysight Technologies Finland Oy
LSTM	Long Short-Term Memory
MAC	Medium Access Control
ML	Machine learning
NGMN	Next Generation Mobile Networks
NPN	Non Public Networks
Nokia	NOKIA DENMARK AS
OFDMA	Orthogonal Frequency Division Multiple Access
PA	Power Amplifier
PIN	Performance Index
PoC	Proof of Concept
PIMRC	International Symposium on Personal, Indoor and Mobile Radio Communications
RESTART	Research and innovation on future telecommunications systems and networks, to make Italy more smart
RIS	Reconfigurable intelligent surfaces
SA	Standalone
Sony	Sony Nordic (Sweden), branch of Sony Europe B.V. (NL)
SNE	Subnetwork Element
SUPERIOT	Truly Sustainable Printed Electronics-based IoT Combining Optical and Radio Wireless Technologies
TC	Technology Component
TERRAMETA	TERahertz Reconfigurable METAsurfaces for ultra-high rate wireless communications
TIMES	THz Industrial Mesh Networks in Smart Sensing and Propagation Environments
UC	Usecase
UMH	UNIVERSIDAD MIGUEL HERNANDEZ DE ELCHE
UK	United Kingdom
UL	Uplink
VNC	Vehicular Networking Conference
VTC	Vehicular Technology Conference
WCNC	Wireless Communications and Networking Conference
XR	Extended Reality

EXECUTIVE SUMMARY

This document presents the summary of the carried-out dissemination, communication and exploitation activities of the 6G-SHINE project during the project and the plans going beyond the duration of the project. The purpose of this summary is to provide directions where the project related communication and dissemination can be found as well as to underline the connectivity of the project to follow up activities.

The provided results are based on the planning provided in D6.1 “Refinement and Update of Dissemination, Exploitation and Communication planning” and are structured by the chapters communication, dissemination, standardization and exploitation.

1 INTRODUCTION

The 6G-SHINE project is centred on the development of new technology components for short-range wireless communications with the purpose of providing ground-breaking research towards future 6G wireless networks. In order to maximize the project impact, it is of utmost importance to communicate the project's achievements to the relevant stakeholders, as this guarantees the practical application of the research findings in the future. Therefore, meticulous planning was done for all endeavours related to communication, dissemination, and exploitation of the project's achievements, just as it is for the actual research process.
This document describes the carried-out communication, dissemination, and exploitation of the 6G-SHINE project, based on the submitted proposal and the deliverable D6.1.

The document is structured in the following main sections:

- **Communication**
  The purpose of communication is keeping the different stakeholders of the project informed about the project's current status. This section describes the used communication channels of the project and how they were utilized.
- **Dissemination**
  The purpose of dissemination is to distribute the knowledge achieved during the project to the different stakeholders of the project. This section describes the carried-out dissemination activities for an optimum transfer of the achievements to the relevant stakeholders.
- **Standardization**
  The purpose of standardization is to align with the ongoing and future standardization process and to transfer the projects achievement into these processes. This section describes the standardization related activities that were carried out.
- **Exploitation**
  The purpose of exploitation is to ensure the sustainability of the project research activities by relating them to exploitation plans of individual or multiple partners. This section describes the carried-out exploitation of the different partners and the plans for exploitation in the near future.

2 COMMUNICATION

2.1 GENERAL KEY MESSAGES

The general key messages of the 6G-SHINE project are:

- The 6G-SHINE technology components allow wireless communication to replace wires for the studied use cases
- 6G-SHINE developed solutions that enable efficient wireless communication inside of industrial, vehicular, and consumer entities
- 6G-SHINE technologies provide solutions for efficient integration of in-X subnetworks into the 6G 'network of networks'

These messages are based on the facts that 6G-SHINE conducts research on multiple technology enablers that have the common goal of enabling wireless communication for use cases and applications with requirements in terms of data rate, latency, and reliability which are significantly more demanding than what is supported by current radio technologies.

2.2 TECHNOLOGY COMPONENT SPECIFIC KEY MESSAGES

The technology map was broken down into 16 technology components (TC) that haven been related to the items of Table 1.

Table 1 6G-SHINE technology components key messages

TECHNOLOGY COMPONENT	KEY MESSAGE
TC1 In-X data traffic models	The development of In-X data traffic models offers realistic traffic patterns and usage profiles specific to in-X scenarios, serving as a key input for system-level evaluations and enabling subsequent components to be assessed under representative operational conditions.
TC2. Channel models for in-X scenarios	Multiband characterization of radio propagation in harsh propagation environments such as in-vehicle and industrial scenarios is of paramount importance for the effective deployment of in-X wireless communication links.
TC3 Sub-THz system models	By optimizing the joint transceiver architecture, it is possible to offload power consumption from the battery-constrained receiver to the transmitter, which is connected to a wired power supply.
TC4 Ultra-short transmissions with extreme reliability	Coded MAC techniques allow for scheduled and grant-free random access with extremely short packets, constrained latency, and high reliability
TC5 Analog/hybrid beamforming/beamfocusing	Hybrid digital and analog at the EM level can help in realizing beamforming and more complex operations with reduced energy consumption and complexity, thus enabling short range communications also with Subnetwork Elements (SNEs).
TC6 Jamming-aware native PHY design	This TC is comprised of two parts, the approximated logarithmic likelihood ratio (ALLR) demapper and the OFDMA based jammer

	resilient scheduler. The demapper helps against wideband jamming, while the scheduler helps against narrow band jamming. Through both simulation and PoC we have validated the functionality of this TC.
TC7 RIS enhancements	RIS can improve the performance of subnetworks in terms of coverage and reliability, but specific technological and optimization algorithms must be considered to avoid unwanted additional interference within and between subnetworks
TC8 Intra-subnetwork macro-diversity	Intra-subnetwork cooperative communication, where one or more low capability devices are able to act as relays towards the serving high-capability node, is able to support high reliable communication while saving over 20 dB of transmit power when combined with smart relay selection. Moreover, with Network coded cooperation it is possible to increase reliability of wireless transmission by a factor of 1000 while keeping the transmission Cycle Time constant
TC9 Flexible/full duplex scheduler	Flexible duplexing enables simultaneous support of UL and DL traffic with different characteristics by avoiding the usage of a same UL/DL switching point. In-band emission generated by the energy leakage of the UL transmissions to the DL subbands is a major performance-limiting factor. Frequency separation leads to a negligible improvement on the performance, while a joint UL/DL power control can substantially mitigate IBE, allowing to leverage the resource allocation flexibility.
TC10 Predictive scheduler	Traffic predictions can be exploited to allocate resources to incoming requests that meet their latency requirements while avoiding resources likely to be needed by future predicted packets. Our proposals demonstrate that predictive schedulers can effectively support deterministic communications in scenarios with mixed traffic flows and varying QoS requirements.
TC11 Latency-aware access in the unlicensed spectrum	Latency is of paramount importance for real time applications. Accessing the wireless medium is one of the most dynamic and unpredictable contributing factors in end-to-end packet latency. Our work, focusing in providing hard prioritization in medium access between best effort and high priority traffic, demonstrated that it is possible to achieve deterministic networking, where latency and throughput can be stable even in high network load scenarios, disregarding best effort loads impact in high priority traffic flows. It is a key enabler for utilising shared spectrum bands for real-time applications.
TC12 Centralized radio resource management	Centralized radio resource management for dense mobile subnetwork can significantly benefit from a combination of prediction techniques and AI-based methods for subband and power allocation. AI techniques allow indeed to reduce the computational burden in the execution phase with respect to the iterative algorithm used for radio resource management,

	provided the model has been trained in the environment of interest. A combination of LSTM for channel prediction and deep neural networks for subband allocation, is able to reduce of a factor of ~4 the amount of signalling overhead towards the central controller, while achieving similar of better performance than the complex iterative heuristic schemes.
TC13 Distributed/hybrid radio resource management.	Distributed solutions for radio resource management, without a central coordination, allow for significant performance improvement with respect to the lack of distributed coordination, though there is still a gap with respect to centralized schemes that benefit from higher environmental visibility. Hybrid solutions, where the central node is still able to control resources of part of the subnetworks, is able to approach similar average performance as the centralized schemes, but the gap still persists at the low percentiles of the data rate distribution.
TC14 Jamming detection and mitigation	Modeling and incorporating stochastic external interference - originated from both benign and malicious sources- into the radio resource management scheme, can lead to a 90% reduction of outage probability with respect to solutions that are unaware of external interference.
TC15 Hybrid management of traffic, spectrum and computational resources	End-to-end compute fabric across the IoT (subnetwork)–edge–cloud continuum, where communication and computing resources are virtually available and orchestrated to enable seamless service provisioning and meet dependable requirements, including deterministic services.
TC16 Coordination of operations among subnetworks in the same entity	Adaptive and efficient coordination mechanisms within and across subnetwork with flexible roles of devices as well as integration into the overlay 6G network to enable new, more localized UCs with high QoS requirements, like e.g XR.

2.3 PROJECT BRANDING

The project branding consists of the 6G-SHINE logo and the associated colours and fonts. An insight of the selected project layout is visualized in the following.

Logo

Font styles

Font: Calibri

Colours:

- Dark: 0x4D,0x5F,0x90
- Light: 0xFF, 0xFA, 0x8A

2.4 COMMUNICATION STRATEGY

The communication strategy of 6G-SHINE followed the principle of reaching external stakeholders at the right time. Consequently, various communication channels have been established to cater to the specific stakeholders that need to be addressed. Furthermore, stakeholders were promptly notified in advance about significant upcoming events pertaining to the project and subsequently reminded of the event's occurrence. Additionally, a summary was provided to stakeholders after the event, ensuring that the key messages conveyed during the event are reinforced and retained. To facilitate this process, a comprehensive communication plan was followed, outlining the design of the communication channels and specifying their intended usage.

For a coherent public presentation, the external communication was built around a single point of contact through which all external communication was directed. Within the 6G-SHINE Consortium AAU acted as this single point of contact and was responsible for the projects' communication activities.

2.5 STAKEHOLDERS AND TARGET GROUPS

One of the first steps of setting up the project communication was to clarify who the communication is intended for, why the project needs to communicate with them and which communication channels will be used. This is summarized in Table 2.

Table 2 List of stakeholder/target group types and related communication channels

Stakeholder/ Target Group	**Communication Purpose**	**Related Communication Channels/Materials**
Equipment and device/IoT manufacturers	Information on the current project achievements for the sake of keeping the stakeholder interested in the project's results. Raising the stakeholders' interest to join follow-up projects and activities. Receiving feedback from stakeholders regarding the project's research relevance to them.	- Booth/presentations at fairs - Presentations at Industrial Conferences and associations - Journal Papers - Leaflets - Newsletters - Press Releases - Social Media - Videos - Webpage - Whitepapers
Industry led alliances and initiatives	Information on the current project achievements for the sake of keeping the stakeholder interested in the project's results. Providing the stakeholder with information so they can act as a proxy	- Booth/presentations at fairs - Presentations at Industrial Conferences and associations - Journal Papers - Leaflets - Newsletters - Press Releases - Social Media

	and distributor for the project key results to lead manufacturers and verticals. Raising the stakeholders' interest in supporting the project's results in the upcoming standardization process. Receiving feedback from stakeholders regarding the project's research relevance to them.	- Videos - Webpage - Whitepapers
Large national 6G initiatives	Information on the current project achievements for the sake of keeping the stakeholder interested in the project results. Receiving feedback from the stakeholder on potential synergies and upcoming collaboration opportunities.	- Presentation at events of national initiatives - Journal Papers - Leaflets - Newsletters - Press Releases - Social Media - Videos - Webpage - Whitepapers
Operators and vertical end-users	Information on the current project achievements for the sake of keeping the stakeholder interested in the project results. Raising the stakeholders' interest to join follow-up projects and activities. Receiving feedback from stakeholders regarding the project research relevance to them.	- Booth/presentations at fairs - Presentations at Industrial Conferences and associations - Journal Papers - Leaflets - Newsletters - Press Releases - Social Media - Videos - Webpage - Whitepapers
Public interest	Information on the current project goals and achievements. Mitigating doubts of the stakeholder regarding the advances in the technology and potential associated risks and promoting the long-term societal benefits of the designed technologies.	- Popular-science magazines - Press Releases - Social Media - Videos - Webpage
Policy makers and regulators	Information on the current project achievements, raising and keeping the stakeholder interested in the project's results.	- Lobbying - Presentations at political events - Press Releases

		- Videos - Whitepapers
Scientific community	Information on the current project achievements for the sake of keeping the stakeholder interested in the project's results. Receiving feedback from the stakeholder on the quality and validity of the research conducted. Receiving feedback from stakeholders regarding the project research relevance to them.	- Papers at Scientific Conferences - Journal Papers - Leaflets - Newsletters - Press Releases - Social Media - Videos - Webpage - Whitepapers
SNS JU management and further SNS JU projects	Information on the current project achievements for the sake of keeping the stakeholder interested in the project results. Receiving feedback on potential synergies and collaboration opportunities.	- Leaflets - Newsletters - Press Releases - Social Media - SNS communication taskforce - Videos - Webpage - Whitepapers
Standardization bodies	Information on the current project achievements for the sake of keeping the stakeholder interested in the project's results. Raising the stakeholders' interest in supporting the projects results in the upcoming standardization process. Receiving the feedback on the project research relevance for the stakeholder.	- Technical input - Whitepapers

The potential stakeholders that have been contacted during the course of the project are listed in Table 3.

Table 3 List of stakeholders associated with a target group

Target Group	Relevant Stakeholders
Industry led alliances and initiatives	5G-ACIA https://5g-acia.org 5GAA http://5gaa.org/ 6G-IA https://6g-ia.eu/ NGMN https://www.ngmn.org/
Large national 6G initiatives	Finland: 6G Flagship (http://6gflagship.com) Germany: 6G Platform (https://www.forschung-it-sicherheit-kommunikationssysteme.de/projekte/6g-plattform Open6GHub (https://www.open6ghub.de/) Netherlands: Future Networks Services Italy: RESTART (https://www.fondazione-restart.it/)
Public interest	The general interested public
Policy makers and regulators	European Commission (EC) and national policy makers like members from the national ministries responsible for research as well as members of the national frequency regulation bodies
Scientific community	Universities, research institutes, individual scientists
SNS JU management and further SNS JU projects	6G SNS https://smart-networks.europa.eu/ 6G SNS project portfolio https://smart-networks.europa.eu/project-portfolio/
Standardization bodies	3GPP https://www.3gpp.org/ ETSI https://www.etsi.org/

2.6 COMMUNICATION CHANNELS

To finalize the communication picture the communication channels to be established are defined by what type of content they need to distribute. This is summarized in Table 4 .

Table 4 List of communication channels established by 6G-SHINE

Communication Channel	Content
Booth/presentations at fairs	Graspable presentation of current achievements of the project centred around demonstrators for the achievements.
Leaflets	High level short summary of the project and its achievements
Newsletters	High level short summaries of project latest achievements and activities
Popular-science magazines and broadcast channels	High level publication or radio/video footage where scientific contents are presented in Layman's terms
Press Releases	High level publication about specific achievement or general progress of the project
SNS communication taskforce telcos	High level dissemination of projects achievements
Social Media	Short current event reporting as a keep alive
Videos	Videos of presentations, laboratory activities videos, and high-quality marketing videos
Webpage	The project in a nutshell with links to all publicly accessible communicate channels, as well as to the public deliverables
Whitepapers	Vision statements of the project as well as an overview of the project's contents and achievements.

Social media

6G-SHINE has launched the following social media channels:

- LinkedIn page: https://www.linkedin.com/company/6g-shine-project
- Twitter: https://twitter.com/6gshine
- YouTube: https://www.youtube.com/@6gshine

These social media channels have been used to promote the project communication and dissemination activities, as well as the most relevant findings of the project, with the aim of reaching a broad audience. At the end of August 2025, the 6G-SHINE LinkedIn page has 8 827 followers, achieving a very good reach.

Website

The 6G-SHINE website (http://6gshine.eu) was launched at the third month of the project. The website collects all the relevant information of the project, including the general background, an overview of the technical scope of the project, the relevant dissemination and communication activities. The website has acted as the main communication tool of the project.

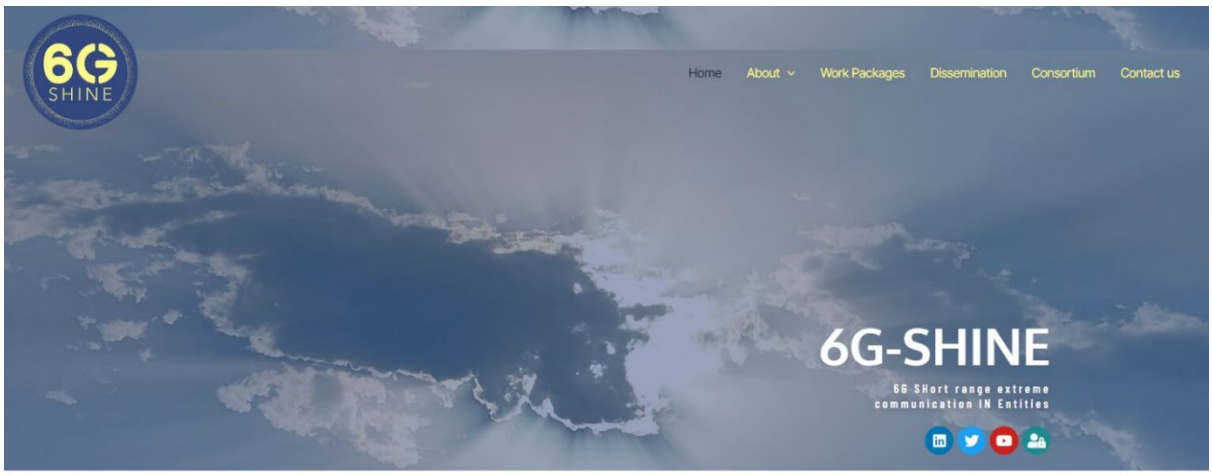

Figure 1 6G-SHINE website homepage

The project website has been regularly updated, and relevant statistics have been monitored.

2.7 CARRIED OUT COMMUNICATION

In D6.1 the communication was planned and carried out later during the course of the project. Table 5 shows the actual carried out communication in relation to the planned communication.

Table 5 Carried out communication activities (bold, black) and originally planned communication activities (in brackets, blue) (status of 25.08.2025)

Time	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	∑
Leaflets		**1** (1)								**1** (1)	**2** **(2)**
Press Releases	**1** (1)			**1** (1)		(1)		(1)	**3**	(1)	**5** **(5)**
Newsletter		**1** (1)			**1** (1)		**1** (1)		**1** (1)	1 (1)	**5** **(5)**
SNS Alignment	42 (1 telco per month)										**42** **(30)**
Social media	63 (2 posts per month) / 827 follower on LinkedIn										**63** **(60)**

Videos	**1** (1)	**1** (1)	- (1)	- (1)	**1** (1)	- (1)	**2** (1)	- (1)	**4** (1)	**4** (1)	**13** **(10)**
Website	**1** (1)	(~2 updates per month)									**1** **(1)**

As shown in Table 5 above, the communication activities closely aligned with the original plan, with the exception of the videos, which were delivered at a later stage. This is to be expected, as video content depends on the progress of the research and the availability of tangible results, which typically emerge towards the end of a project. This learning will be taken into account in the planning of future projects. Out of the 13 generated videos, 8 were uploaded in the 6G-SHINE YouTube channels, while others are in the YouTube channel of SNS JU, IEEE ComSoc, or the channels of the individual partners.

3 DISSEMINATION

3.1 DISSEMINATION STRATEGY

The dissemination strategy of 6G-SHINE follows the principle of creating impact at the various stakeholders of the project. This means that different levels of dissemination content are defined such that it is fitting to the stakeholder that is to be addressed and empowers the stakeholder to react to the project in a well-informed way that is helpful to reach the project's goals.

The project's key dissemination goal was to make the projects results impactful.

- Making the projects achievements common knowledge.
- Inspiring other scientists in their research.
- Paving the ground for follow up research advancing the project even further.
- Preparing the adaption of the achievements from research into the commercial world.

The dissemination plan was managed by the dissemination manager (Frank Burkhardt from Fraunhofer IIS) in cooperation with the overall project management team.

3.2 DISSEMINATION CHANNELS

In order to fulfil the dissemination strategy, the relevant dissemination channels and their expected audience needed to be defined. This was completed by clarifying the scientific level of the dissemination and a clear view on the intended target number, which is the number of usages of a certain dissemination channel. The channels, target audience and dissemination level are defined in Table 6, the target numbers for the dissemination activities are defined in Table 8.

Table 6 List of communication channels established by 6G-SHINE

Dissemination Channel	Target Audience	Dissemination Level
Booth/presentations at event	Scientific community, equipment and device/ IoT manufacturers, operators and vertical end users, industry led alliances and initiatives, policy makers and regulators	Management to deep scientific level depending on the level of event
Data Sets and open implementations	Wireless and AI scientific community	Deep scientific level for detailed analysis and evaluation
Demo Days	Scientific community, equipment and device/IoT	Management and technical level demonstrations

	manufacturers, operators and vertical end users	
ITU/ML contest	Scientific community (wireless and AI)	Scientific level contest
Journal Articles*	Scientific community	Scientific publications of individual topics
Joint Articles*	Scientific community	Scientific publications of broader topics
Papers at Scientific Conferences*	Scientific community	Deep dive scientific publications of individual topics
Popular-science magazines*	The general public	Scientific contents presented in Layman's terms
Presentation at events of national initiatives	Scientific leaders	The scientific level depending on the format of the event.
Presentations at Industrial Conferences and associations	Industrial leaders	The scientific level depending on the format of the event
Special issues*	Scientific community	Scientific publications providing generic to deep dive content of a singular topic
Whitepapers*	Scientific community, equipment and device/ IoT manufacturers, operators and vertical end users,	Vision statements and project achievements
Workshops and Training	Scientific community, equipment and device/ IoT manufacturers, operators and vertical end users	Tutorials/trainings starting from overview level to scientific deep dive

*All scientific papers by all partners will be also published in an open access repository.

The rationale for the different dissemination activities is provided in the following.

- **Scientific publications**: 6G-SHINE partners have aimed at publishing its main technological and academic results in top quality IEEE conferences, magazines and journals. The selected conferences were PIMRC, ICEAA/AWPC, ICC, EUCAP, VNC, ETFA, VTC, CSCN, ICNC, Globeom, ISCC, WCNC. Magazines of interest were IEEE Open Journal of the Communications Society, IEEE Transactions on Antennas and Propagation, IEEE Transactions on Vehicular Technology, IEEE Internet of Things Journal, IEEE Journal on Selected Areas in Communications. As detailed in the data management plan (deliverable D1.4), scientific publications have been made open access via trusted repositories such as ArXiv or Zenodo. A Zenodo repository dedicated to the project was also established. Participation to conferences also entailed presentations to the scientific community. 6G-SHINE members also contributed to the review of scientific papers in their respective fields, therefore ensuring the influence of the 6G-SHINE vision onto the research community.

- **Open datasets and Simulation package:** 6G-SHINE offers to the research community synthetic datasets related to interference traces in hyper-dense mobile subnetwork scenarios generated via system level simulations; also, it will offer traces of the data traffic in realistic in-vehicle data traffic emulator. In addition, synthetic radio propagation simulation package is also provided. The data sets and their contributors are: "
    - In-Vehicle Network Traffic Dataset (UMH), https://zenodo.org/records/15655963
    - Channel data for RIS assisted communication in a corridor scenario (CNIT), https://zenodo.org/records/15609032
    - Scattering Measurements of Building Materials in the FR3 band (CNIT), https://zenodo.org/records/15610052
    - MATLAB Simulation Package for Reconfigurable Intelligent Surface (RIS) Modelling Based on an Antenna Array-Like Approach (CNIT),https://zenodo.org/records/15657376
    - Simulated Channel state information for In-factory Subnetworks, https://zenodo.org/records/10908382
    - Simulation Code and Synthetic Channel and Mobility Traces for Dynamic Subnetwork Scenarios with Optional External Interference, https://zenodo.org/records/16386272

  Further details on the delivered datasets are provided in the data management plan D1.4.

- **ITU machine learning (ML) challenge:** At the annual ITU ML challenges (https://aiforgood.itu.int/about-ai-for-good/aiml-in-5g-challenge/) in 2024 a ITU/ML challenge on radio resource management in in-X subnetworks was provided. The proposed challenge was solving a radio resource management problem in dense subnetworks using AI/ML and has been organized in collaboration with the SNS CENTRIC project. The challenge has been presented by AAU in two dedicated webinars organized by ITU. The challenge has attracted the interest of few researchers worldwide. The solution developed by Nokia Bell Labs, France, has been selected as winner of the challenge, and awarded in a webinar organized on August 25, 2025.

- **Booths at events, technical presentations and demonstrations.** Besides conference paper presentations, technical presentations (including invited talks) in relevant IEEE events or workshops on the scope of the 6G-SHINE research and its progress, were given, with the objective of reaching academic and industry audience. The detailed list of presentations is provided in chapter 4.5. Presentations in the form of booths and posters were given at the EuCNC/6G-Summit (2023, 2024, 2025), COST INTERACT (2024) and at the 6G-Platform Berlin (2024).

- **Workshops and special sessions:** Additionally, 6G-SHINE related workshops and special sessions to disseminate the outcomes to the main stakeholders and end-users of the industry and research community have been carried out, mainly in the context or in conjunction of international IEEE

conferences and/or ITU events or with other SNS-JU projects. The detailed list of workshops is provided in chapter 4.5.

- **PhD courses:** A PhD course on "short-range radio propagation" was held at the European school of Antennas in Cesenatico, Italy, September 2023, to disseminate the early project's finding directly to next generation PhDs.

- **Demo event:** As a demo event able to reach a wide range of audiences the EuCNC/6G-Summit 2025 was chosen. At this event multiple PoCs showcasing the projects achievements were presented to guests from various universities, industries, including interested parties of telecommunications supply-chain, verticals and from the research community. Our demos were also shown at the COST INTERACT meeting in Helsinki, in June 2024, and at the Bosch Automotive Ethernet conference 2024.

- **Presentations to industry alliances and policy makers:** Many of the 6G-SHINE partners are members of relevant international industry alliances, so the results of the project were presented in such industry fora. The detailed list of presentations is provided in chapter 4.5.

- **Alignment with other SNS projects:** 6G-SHINE has partnered with multiple SNS projects (CENTRIC, Hexa-X-II, SUPERIOT, TIMES and TERRAMETA) for joint dissemination activities. Those are listed in the next section. We have also significantly contributed to joint SNS dissemination activities such as the SNS Architecture Whitepaper, the SNS Sustainability Whitepaper, the book "6G to Build a Sustainable Future".

- **Summary Whitepaper of research achievements:** During the project, we have released or contributed to multiple whitepapers. A first whitepaper on the project vision (based on the paper presented at the Future Network World Forum 2023) was released in our Zenodo repository in November 2023. A whitepaper presenting a concise overview of the architectural enhancements for in-X subnetworks and their integration in the 6G network of networks was released in July 2025. Further, at the current date we are working on a final whitepaper summarizing the main project results. Besides, we have contributed to multiple collaborative whitepapers with other SNS projects: the whitepaper on 6G architecture released by the SNS Architecture Working Group, bringing in our in-X subnetworks concept in the picture; the SNS Sustainability whitepaper led by the Sustainability taskforce established by the SNS technical board, where we have also taken section editor roles; the 6G IA Vision Working Group whitepaper, European Vision for the 6G network ecosystem. We are also contributing to the whitepaper on "Media/entertainment" edited by SNS JU, though the effort has just started at the time of writing this deliverable.

- **Special issues:** We have organized two special issues in prestigious IEEE journals. The special issue 6G local area networks for IEEE Wireless Communication Magazine were led by the coordinator Gilberto Berardinelli and organized in collaboration with Hexa-X-II, and other international experts. It was launched in the spring 2025 and received 16 submissions. The special issue will be published in October 2025. The second special issue is currently under evaluation by the IEEE Network journal, expected to be published in May 2026.

3.3 JOINT DISSEMINATION WITH OTHER SNS JU PROJECTS

During the course of the 6G-SHINE has been collaborating in general with the other SNS-JU projects and has done networking as well as an exchange of status. From this a deeper cooperation and collaboration with some SNS-JU projects in regard to dissemination has emerged.

Table 7 Carried out dissemination with other SNS JU projects

Project	Date	Common Dissemination Activity
CENTRIC	• 03.06.2024 • 22.05.2024 (launched)	• Workshop on 6G holistic radio design, in collaboration with Hexa-X-II • ITU challenge on radio resource management in dense in-X subnetworks
HEXA-X-II https://hexa-x-ii.eu/I	• 14.02.2024 • 03.06.2024 • 03.06.2024 • 13.10.2024 • 17.10.2024 • 03.06.2025 • 03.06.2025 • Fall 2025	• Presentation at the 6G series workshop by Hexa-X-II • EuCNC 2024: Workshop on 6G holistic radio design, in collaboration with CENTRIC • EuCNC 2024: Presentation at the EuCNC 6G series workshop by Hexa-X-II • Special issue on 6G local area networks at IEEE Wireless Communication magazine, accepted proposal, in collaboration with Hexa-X-II • Presentation at Hexa-X-II Workshop on Architecture and Standardization • EuCNC 2025: Presentation by Meng Li, IMEC, " Energy efficiency aspects from PA models to AR/VR applications in Hexa-X-II and 6G SHINE projects." • Second workshop on 6G holistic radio design, organized in collaboration with Hexa-X-II • Contribution to the book "6G to Build a Sustainable Future", Wiley, edited by Hexa-X-II
SUPERIOT https://superiot.eu/	• 29.11.2024 14.03.2025 27.06.2025	• 3 joint webinars on sustainable wireless design (together with TERRAMETA)
TERRAMETA https://terrameta-project.eu/	• 29.11.2024 14.03.2025 27.06.2025 • 02.01.2024 • 09.02.2024	• 3 joint webinars on sustainable wireless design (together with SUPERIOT) • Joint workshop with TIMES, in synergy with RESTART-IN • Workshop proposal on Short range extreme communication, in collaboration with TIMES

	• 23.04.2024 • 26.03.2025 • 15.09.2025	• Panel at Hannover Fair 2024: "Is Industry waiting for 6G?" • Joint workshop with TIMES • IEEE CSCN 2025 - Special Session proposal with TIMES (September 2025)
TIMES http://www.times6g.eu/	• 02.01.2024 • 09.02.2024 • 22.09.2024 • 26.03.2025 • 23.04.2024 • 19.05.2025 • 15.09.2025	• Joint workshop with TERRAMETA, in synergy with RESTART-IN, Bologna, Italy. • Workshop proposal on Short range extreme communication, in collaboration with TERRAMETA • EuMW 2024: Workshop on "Towards THz communication" • Joint workshop with TERRAMETA • Panel at Hannover Fair 2024: "Is Industry waiting for 6G?" • Webinar on electromagnetic signal processing • IEEE CSCN 2025 - Special Session proposal with TERRAMETA (September 2025)

3.4 CARRIED OUT DISSEMINATION

In D6.1 the dissemination was planned and carried out later during the course of the project. Table 8 shows the actual carried out communication in relation to the planned communication.

Table 8 Carried out dissemination and in brackets the planned dissemination (status 25.08.2025)

Time	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**∑**
Booth/presentations at event		**0** (1)				**4** (1)				**1** (1)	**5** **(3)**
Data Sets and open implementations										**3** **+1** (3 +1)	**3+1** **(3+1)**
Demo Days										**1** (1)	**1** **(1)**
ITU/ML contest						**1**	**0** (1)				**1** **(1)**

Journal Articles*	**2**	**1**	**1** (1)	**2**	**3** (1)	**2** (1)	**2** (1)	**3** (1)	**3** (1)	**2** (2)	**21** **(8)**
Joint Articles*			**0** (1)	**2**		**2**	**1** (1)	**2**	**2**	**3** (1)	**12** **(3)**
Papers at Scientific Conferences*		**1**	**5** (2)	**0** (2)	**4** (2)	**2** (2)	**3** (2)	**6** (2)	**10** (4)	**7** (4)	**37** **(20)**
Popular-science magazines* and popular broadcast				**1** (1)			**0** (1)		**1**	**0** (1)	**2** **(3)**
Presentation at events of national initiatives		**1** (1)			**1**	**0** (1)				**0** (1)	**2** **(3)**
Presentations at Industrial Conferences and associations	**3**	**1** (1)	**2**	**3** (1)	**2**	**1** (1)		**1** (1)	**3**	**1** (1)	**17** **(5)**
Special issues*							**1** (1)			**1** (1)	**2** **(2)**
Webinars	**1**			**1**		**1**	**2**		**2**	**1**	**8** **(8)**
Whitepapers*		**1**	**1** (1)				- (1)	**2**	**1**	**1** (1)	**6** **(3)**
Workshops and Training			**4**	**3**		**5**	**5** (1)		**5**	**6** (1)	**28** **(2)**

*All scientific papers by all partners have also been published in an open-access repository.

As can be seen. the carried-out dissemination generally was higher than the planned dissemination output. This highlights that the carried-out research achieved more results than conservatively estimated at the beginning of the project. Also, it underlines the interest of the research topic in from the scientific as well as from the industrial side and can be taken as a lesson learned for future projects.

3.5 DISSEMINATION RESULTS

The overview of the done dissemination is provided in Table 9 .

Table 9 Overall carried out dissemination (Status of 25.08.2025)

Status of Dissemination	Plan	Current	%
Booth at Event	3	5	167%
Conference Paper	20	31	155%
Contributions to Prestandardization	4	15	375%
Data sets	3	3	100%
Demo Day	1	2	200%
ITU/ML Contest	1	1	100%
Joint Articles	4	12	300%
Journal Article	8	21	262,5%
Presentations Industry Forum	6	17	283%
Simulation Code	1	1	100%
Special issues	2	2	100%
Webinars	8	8	100%
Whitepapers	3	6	200%
Workshop and Training	2	28	1400%

In the following, a compilation of the publicly available publications that have been done in the scope of the project is provided.

Table 10 Links to publicly available dissemination contributions (status 28.08.2025)

Nr.	Title	Authors	Title of the journal or equivalent	Link
1	An Efficient Ray-Based Modeling Approach for Scattering from Reconfigurable Intelligent Surfaces	Vittorio Degli-Esposti; Marina Barbiroli; Silvi Kodra; Matteo Albani; Enrico Maria Vitucci	IEEE Transactions on Antennas and Propagation	10.1109/TAP.2024.3359288
2	Coded Spatial Random Access in the Near Field	Enrico Testi, Giulia Torcolacci, Nicolò Decarli, Davide Dardari, Enrico Paolini	IEEE Internet of Things Journal	10.1109/JIOT.2025.3569982
3	Establishing Multi-User MIMO	Davide Dardari; Marina Lotti;	IEEE Open Journal of the	10.1109/ojcoms.2023.3289326

	Communications Automatically Using Retrodirective Arrays	Nicoló Decarli; Gianni Pasolini	Communication Society	
4	Experimental Analysis of Channel Frequency, Space, and Object Consistency at the W-Band	Le Yu, Yifa Li, Fengchun Zhang, Pekka Kyösti, Gert Frølund Pedersen, Wei Fan	IEEE Antennas and Wireless Propagation Letters	10.1109/LAWP.2024.3390617
5	Experimental Over-the-Air Diagnosis of 1-Bit RIS Based on Complex Signal Measurements	Yifa Li, Fengchun Zhang, Kim Olesen, Zhinong Ying, Wei Fan	IEEE Antennas and Wireless Propagation Letters	10.1109/LAWP.2024.3367377
6	Goal-Oriented Interference Coordination in 6G In-Factory Subnetworks	Daniel Abode, Pedro Maia de Sant Ana, Ramoni Adeogun, Alexander Artemenko, Gilberto Berardinelli	IEEE Journal on Selected Areas in Communications	10.1109/JSAC.2025.3574586
7	Grant-Free Random Access With Backscattering Self-Conjugating Metasurfaces	Davide Dardari, Marina Lotti, Nicolò Decarli, Gianni Pasolini	IEEE Transactions on Cognitive Communications and Networking	10.1109/TCCN.2024.3449648
8	MMSE Design of RIS-aided Communications With Spatially-Correlated Channels and Electromagnetic Interference	Wen-Xuan Long, Marco Moretti, Andrea Abrardo, Luca Sanguinetti, Rui Chen	IEEE Transactions on Wireless Communications	10.1109/TWC.2024.3449074
9	Mm-Wave Building Penetration Losses: A Measurement-	Silvi Kodra, Marina Barbiroli, Enrico Maria Vitucci,	IEEE Open Journal of Antennas and Propagation	10.1109/OJAP.2024.3355817

	Based Critical Analysis	Franco Fuschini, Vittorio Degli-Esposti		
10	Multiband Measurement-Based Characterization of Building Materials	Silvi Kodra, Elena Bernardi, Nicolò Cenni, Jiahao Hu, Marina Barbiroli, Franco Fuschini, Enrico M. Vitucci, Jose-Maria Molina Garcia-Pardo, María-Teresa Martínez-Inglés, Sana Salous, Vittorio Degli-Esposti	IEEE Open Journal of Antennas and Propagation	10.1109/OJAP.2025.3587403
11	Multiple-Frequency-Bands Channel Characterization for In-vehicle Wireless Networks	Mengting Li, Yifa Li, Qiyu Zeng, Kim Olesen, Fengchun Zhang, Wei Fan	IEEE Transactions on Antennas and Propagation	10.1109/TAP.2025.3526860
12	On the required radio resources for ultra-reliable communication in highly interfered scenarios	Gilberto Berardinelli; Ramoni Adeogun	IEEE Communication Letters	10.1109/lcomm.2023.3265265
13	Optimizing Reconfigurable Intelligent Surfaces in Multi-User Environments: A Multiport Network Theory Approach	Andrea Abrardo	IEEE Transactions on Communications	10.1109/TCOMM.2024.3454704

	Leveraging Statistical CSI			
14	Over-the-Air Diagnosis of 1-Bit RIS Based on Amplitude-Only Measurement	Fengchun Zhang, Yifa Li, Gert Pedersen, Wei Fan	IEEE Transactions on Vehicular Technology	10.1109/TVT.2024.3524597
15	Power Control for 6G In-Factory Subnetworks With Partial Channel Information Using Graph Neural Networks	Daniel Abode, Ramoni Adeogun, Gilberto Berardinelli	IEEE Open Journal of the Communication Society	10.1109/OJCOMS.2024.3396749
16	Power Efficient Cooperative Communication Within IIoT Subnetworks: Relay or RIS?	Hamid Reza Hashempour, Gilberto Berardinelli, Ramoni Adeogun, Eduard A. Jorswieck	IEEE Internet of Things Journal	10.1109/JIOT.2024.3521001
17	Power Minimization with Rate Constraints for Multi-User MIMO Systems with Large-Size RISs	Silvia Palmucci, Giulio Bartoli, Andrea Abrardo, Marco Moretti, Marco Di Renzo	IEEE Transactions on Communications	10.1109/TCOMM.2025.3582720
18	Resilient DNN for joint sub-band allocation and power control in mobile factory subnetworks	Saeed Hakimi, Ramoni Adeogun, Gilberto Berardinelli	EURASIP Journal on Wireless Communications and Networking	https://doi.org/10.1186/s13638-025-02468-7
19	Secure SWIPT in the Multiuser STAR-RIS Aided MISO Rate Splitting Downlink	Hamid Reza Hashempour, Hamed Bastami, Majid Moradikia, Seyed A. Zekavat, Hamid Behroozi,	IEEE Transactions on Vehicular Technology	10.1109/TVT.2024.3398057

		Gilberto Berardinelli, A. Lee Swindlehurst		
20	Virtual Antenna Array-Based Channel Sounding at 300 GHz: Implementation and Field Measurements	Yejian Lyu, Fengchun Zhang, Zhiqiang Yuan, Pekka Kyösti, Wei Fan	IEEE Antennas and Wireless Propagation Letters	10.1109/LAWP.2024.3437674
21	Multiband Characterization of Radio Propagation Into and Inside Vehicles *	Elena Bernardi, Mengting Li, Nicolò Cenni, Yifa Li, Vittorio Degli-Esposti, Fengchun Zhang, Enrico M. Vitucci	Submitted to IEEE Transactions on Vehicular Technology	https://doi.org/10.5281/zenodo.16942498
22	A Macroscopic Bilateral Modeling Approach for Reflective and Transmissive Metasurfaces	Silvi Kodra, Enrico M. Vitucci, Marina Barbiroli, Matteo Albani, Vittorio Degli-Esposti	2024 18th European Conference on Antennas and Propagation (EuCAP)	10.23919/EuCAP60739.2024.10500949
23	A Macroscopic Ray-based Model for Reflective Metasurfaces	Vittorio Degli-Esposti, Silvi Kodra, Marina Barbiroli	2023 International Conference on Electromagnetics in Advanced Applications (ICEAA)	10.1109/ICEAA57318.2023.10297648
24	A Power Efficient Cooperative Communication Protocol for 6G In-Factory Subnetworks	Hamid Reza Hashempour, Gilberto Berardinelli, Ramoni Adeogun	EuCNC & 6G summit 2024	10.1109/EuCNC/6GSummit60053.2024.10597117
25	An Automated Over-the-Air Radiated	Yifa Li, Fengchun Zhang, Kim	EuCAP2024	10.23919/EuCAP60739.2024.10501131

	Testing Platform for Reconfigurable Intelligent Surface	Olesen, Zhinong Ying, Gert Frølund Pedersen, Wei Fan		
26	Boosting Short-Range Wireless Communications in Entities: the 6G-SHINE Vision	Gilberto Berardinelli, et al.	IEEE Future Networks World Forum	10.1109/FNWF58287.2023.1052055341
27	Characterization of In-Vehicle Network Sensor Data Traffic in Autonomous Vehicles	L. Lusvarghi, B. Coll-Perales, J. Gozalvez, K. Aghababaiyan, M. Almela, M. Sepulcre	IEEE VNC 2024	10.1109/VNC61989.2024.10575960
28	Communication-Aware Dynamic Speed Control for Interference Mitigation in 6G Mobile Subnetworks	Daniel Abode, Pedro Maia de Sant Ana, Ramoni Adeogun, Gilberto Berardinelli	2024 IEEE Conference on Standards for Communications and Networking (CSCN)	10.1109/CSCN63874.2024.10849686
29	Comparative Analysis of Sub-band Allocation Algorithms in In-body Sub-networks Supporting XR Applications	Saeed Bagherinejad, Thomas Jacobsen, Nuno K. Pratas, Ramoni O. Adeogun	WCNC 2024	10.1109/WCNC57260.2024.10570689
30	Control-Aware Transmit Power Allocation for 6G In-Factory Subnetwork Control Systems	Daniel Abode, Pedro Maia de Sant Ana, Alexander Artemenko, Ramoni Adeogun, Gilberto Berardinelli	2024 IEEE 100th Vehicular Technology Conference (VTC2024-Fall)	10.1109/VTC2024-Fall63153.2024.10757544
31	DRL-Based Distributed Joint Sub-Band	Saeed Bagherinejad, Thomas Jacobsen,	2025 IEEE Wireless Communications and	10.1109/WCNC61545.2025.10978802

	Allocation and Power Control for eXtended Reality Over In-Body Subnetworks	Nuno K. Pratas, Ramoni O. Adeogun	Networking Conference (WCNC)	
32	Deterministic Task Offloading and Resource Allocation in the IoT-Edge-Cloud Continuum	Aghababaiyan, Keyvan, Coll-Perales, Baldomero, Gozalvez, Javier	IEEE VTC-Spring 2025	https://doi.org/10.5281/zenodo.15083356
33	Distributed Compute Offloading in Local Communications	Sameh Eldessoki, Christian Hofmann, Dimitrios Alanis, Panagiotis Botsinis, Tarik Tabet	IEEE ICNC 2025	10.5281/zenodo.14264327
34	Empirical Characterization of In-Vehicle Propagation at Different Frequency Bands	Elena Bernardi, Mengting Li, Nicolò Cenni, Vittorio Degli-Esposti, Fengchun Zhang, Enrico M. Vitucci	2025 19th European Conference on Antennas and Propagation (EuCAP)	10.23919/EuCAP63536.2025.10999900
35	Enabling VNA Based Channel Sounder for 6G Research: Challenges and Solutions	Wei Fan, Zhiqiang Yuan, Yejian Lyu, and Gert F. Pedersen	EuCAP2024	10.23919/EuCAP60739.2024.10501372
36	Experimental Study of Spatial Statistics for Ultra-Reliable Communications	Tobias Kallehauge, Anders E. Kalør, Fengchun Zhang, Petar Popovski	IEEE ICC 2024	10.1109/ICC51166.2024.10622425
37	Federated Multi-Agent DRL for Radio Resource Management	Bjarke Madsen, Ramoni Adeogun	IEEE PIMRC 2024	10.1109/PIMRC59610.2024.10817320

	in Industrial 6G in-X subnetworks			
38	Frequency-selective Dynamic Scattering Arrays for Over-the-air EM Processing	Davide Dardari	URSI EMTS 2025	https://doi.org/10.48550/arXiv.2502.07336
39	Joint Ap and Hmd Power Optimization of Sub-Thz Virtual Reality Systems	Meng Li, Yiğit Ertuğrul, Abdur Rahman Mohamed Ismail, Claude Desset, Sofie Pollin	2025 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit)	10.1109/EuCNC/6GSummit63408.2025.11036972
40	Joint Resource Allocation and Link Adaptation for Beyond 5G Time Sensitive Communications	Christos Tsakos, Fotis Foukalas, Theodoros Tsiftsis	2024 IEEE Conference on Standards for Communications and Networking (CSCN)	10.1109/CSCN63874.2024.10849716
41	Mid-Band Propagation Measurements in Industrial Environments	Juha-Matti Runtti, Usman Virk, Pekka Kyösti, Lassi Hentilä, Jukka Kyröläinen, Fengchun Zhang	2025 19th European Conference on Antennas and Propagation (EuCAP)	10.23919/EuCAP63536.2025.10999450
42	On Transmissive RIS for mm-Waves Outdoor-to-Indoor Coverage Enhancement	Silvi Kodra, Simone Del Prete, Elena Bernardi, Franco Fuschini, Marina Barbiroli, Enrico Maria Vitucci, Vittorio Degli-Esposti	2025 19th European Conference on Antennas and Propagation (EuCAP)	10.23919/EuCAP63536.2025.11000075

43	Over the Air Computation for Distributed Power Control Using SDR Testbed	Anastasios Grammenos, Christos Tsakos, Fotis Foukalas	2025 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit)	10.1109/EuCNC/6GSummit63408.2025.11036924
44	Predictive Dynamic Scheduling for Deterministic Communications in Beyond 5G	Riaz, Syed Morsleen Lucas-Estañ, M. Carmen, Coll-Perales, Baldomero, Gozalvez, Javier	IEEE ISCC 2025	https://doi.org/10.5281/zenodo.15187860
45	Rate-Conforming Sub-Band Allocation for In-Factory Subnetworks: A Deep Neural Network Approach	Saeed Hakimi, Ramoni Adeogun, Gilberto Berardinelli	EuCNC & 6G summit 2024	10.1109/EuCNC/6GSummit60053.2024.10597067
46	Robust Resource Management for Mission-Critical In-Factory Subnetworks under External Interference	Hakimi, Saeed, Koteshwar Srinath, Pavan, Bagherinejad, Saeed, Adeogun, Ramoni, Berardinelli, Gilberto	IEEE VTC-Spring 2025, (3rd International Workshop on Mission Critical Communications)	https://doi.org/10.5281/zenodo.15657826
47	Scalable Deterministic Task Offloading and Resource Allocation in the IoT-Edge-Cloud Continuum	Aghababaiyan, Keyvan, Coll-Perales, Baldomero, Gozalvez, Javier	IEEE ISCC 2025	https://doi.org/10.5281/zenodo.15187788
48	Secure Rate Splitting in STAR-RIS Assisted Downlink MISO Systems	Hamid Reza Hashempour, Gilberto Berardinelli	2024 IEEE MeditCom	10.1109/MeditCom61057.2024.10621324

49	Spatially Selective Reconfigurable Intelligent Surfaces Through Element Permutation	Fredrik Rusek, Jose Flordelis, Kun Zhao, Erik Bengtsson, Olof Zander	IEEE ICC 2024	10.1109/ICC51166.2024.10622284
50	Subnetworks: A Novel Architectural Paradigm for 6G	Dimitrios Alanis, Christian Hofmann, Sameh Eldessoki, Panagiotis Botsinis, Tarik Tabet, Sree Vallath	2025 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit)	10.1109/EuCNC/6GSummit63408.2025.11037196
51	Uniform Ray Description for PO Scattering from Reconfigurable Intelligent Surfaces	E. M. Vitucci, N. Cenni, V. Degli-Esposti, and M. Albani	URSI-B EMTS 2025	10.5281/zenodo.15634118
52	Unsupervised Deep Unfolded PGD for Transmit Power Allocation in Wireless Systems	Adeogun, Ramoni	IEEE PIMRC 2023	10.1109/pimrc56721.2023.10293755
53	Unsupervised Graph-based Learning Method for Sub-band Allocation in 6G Subnetworks	Daniel Abode, Ramoni Adeogun, Lou Salaün, Renato Abreu, Thomas Jacobsen, Gilberto Berardinelli	IEEE VTC 2024	10.1109/VTC2024-Fall63153.2024.10757647
54	Wi-Fi 6 Cross-Technology Interference Detection and Mitigation by Ofdma: an Experimental Study	Thijs Havinga, Xianjun Jiao, Wei Liu, Baiheng Chen, Adnan Shahid, Ingrid Moerman	2025 Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit)	10.1109/EuCNC/6GSummit63408.2025.11037177

55	A Grant-free Coded Random Access Scheme for Near-field Communications	Enrico Testi, Giulia Torcolacci, Nicolò Decarli, Davide Dardari, Enrico Paolini	IEEE ICC 2025	https://doi.org/10.48550/arXiv.2508.15673
56	Deterministic Task Scheduling in In-Vehicle Networks for Software-Defined Vehicles	Keyvan Aghababaiyan, Baldomero Coll-Perales, Luca Lusvarghi, Javier Gozalvez	2025 IEEE/CIC International Conference on Communications (ICCC)	https://doi.org/10.5281/zenodo.16925373
57	Predictive Configured Grant Scheduling for Deterministic Wireless Communications	Syed Morsleen Riaz, M.Carmen Lucas-Estañ, Baldomero Coll-Perales, Javier Gozalvez	IEEE VTC2025-Spring	https://doi.org/10.5281/zenodo.16925403
58	Empirical Study of Scattering from Construction Materials at 10 GHz	Pekka Kyösti, Usman Virk, Elena Bernardi, and Enrico M. Vitucci	URSI EMTS 2025	https://doi.org/10.5281/zenodo.15634192

As of the end of August 2025, the project's publication record comprises 21 journal articles and 37 conference papers. Of these, 12 are the result of collaborative efforts among multiple partners. The majority of the collaborative works focus on radio resource management in dense subnetworks—particularly goal-oriented approaches—and on radio channel characterization. In addition, a joint conference paper outlining the overall vision of the 6G-SHINE project was co-authored by all partners and presented at the Future Network World Forum 2023. All publications have been made available in open access repositories, such as the 6G-SHINE Zenodo repository, or ArXiv and TechRiv.

Two of the published papers received a Best Paper Award, specifically:

- Christos Tsakos, Fotis Foukalas, Theodoros Tsiftsis, "Joint Resource Allocation and Link Adaptation for Beyond 5G Time Sensitive Communications", Best Paper Award at IEEE CSCN 2024.
- S. Kodra, M. Barbiroli, E. M. Vitucci, F. Fuschini and V. Degli Esposti, "Mm-Wave Building Penetration Losses: A Measurement-Based Critical Analysis", Best Paper Award at IEEE Open Journal of Antennas and Propagation for year 2024

Besides the listed publications, further papers are in preparation based on the later project results, which could not be submitted within the project duration. We anticipate that scientific dissemination of the project findings will continue at least until July 2026.In addition to the publications also presentations in multiple contexts were given to reach diverse audiences. The following table provides a summary of these occasions.

Table 11 Presentations, Keynotes and panels (status 31.03.2025)

Nr	Title	Presenter(s)	Occasion
1	Presentation of the project at the ETSI meeting, highlighting its standardization potential	Gilberto Berardinelli	ETSI meeting, February 2023
2	Presentation of the project at the SNS webinar 4	Gilberto Berardinelli	SNS webinar 4, March 2023
3	Poster proposal submitted at EuCNC2023	Gilberto Berardinelli	Poster at EuCNC2023
4	Keynote title "Holographic Radio: When electromagnetism meets signal processing""	Davide Dardari	Keynote at ICC 2023 (Workshop on Holographic MIMO)
5	Presentation on in-X subnetworks, available at the Global 5Gevolution youtube channel	Gilberto Berardinelli	Global 5G Evolution, October 2023
6	Presentation as Invited Paper in the Special Session "Recent advances and Future Trends in Methodologies and Technologies for Smart EM Environments".	Davide Dardari	ICEAA/AWPC 2023 Conference

	Accepted paper title: "Reconfigurable Electromagnetic Environments: A Signal Processing Approach".		
7	Keynote title "6G Subnetworks for Vertical Industries: Opportunities and Challenges "	Gilberto Berardinelli	Keynote at VTC-Fall 2023
8	PhD course on "short-range radio propagation" - European school of Antennas	Vittorio Degli Esposti	PhD school, September 2023
9	Special Session on Key challenges for enabling high-performance short-range communications in extreme propagation environments	Davide Dardari	Special session at CSCN 2023
10	Presentation of the 6G-SHINE vision, and participation to a panel discussion on 6G challenges in Europe	Gilberto Berardinelli	IEEE Future Networks World Forum, October 2023
11	Participation on a panel discussion on the Challenges for 6G in Europe, with representatives of other EU projects	Gilberto Berardinelli	IEEE Future Networks World Forum, October 2023
12	Overview of the latest project activities and achievements in the plenary session of 7th Technical Meeting of COST action INTERACT in Lisbon	Enrico M. Vitucci	COST INTERACT in Lisbon, January 2024

13	Joint SNS TIMES/6G-SHINE/TERRAMETA workshop, in sinergy with RESTART-IN	Davide Dardari	Workshop in Bologna, Italy, February 2024
14	Presentation on short-range communication with extreme requirements	Gilberto Berardinelli	Presentation at the 6G series workshop by Hexa-X-II, February 2024
15	Webinar on Macroscopic ray based modeling of scattering from Reconfigurable Intelligent Surfaces (RIS)	Vittorio Degli Esposti, Enrico Maria Vitucci	Online webinar, February 2024
16	At their booth, Keysight presented research activities across various 6G SNS JU projects including 6G SHINE	Usman Virk	Presentation of 6G-SHINE at MWC'24, February 2024
17	Second webinar on sustainable wireless design	Hamid Reza Hashempour	Second 6G-SHINE/SUPERIOT/TERRAMETA webinar on 6G sustainable wireless design, March 2024
18	Panel Topic: "Is Industry waiting for 6G?"	Frank Burkhardt	Panel at Hannover Fair, April 2024
19	Session on: Bending Propagation to the Needs of the Network with Smart Radio Environments	Davide Dardari	5G Italy, April 2024
20	Webinar introducing the AI/ML challenge on in-X subnetworks	Saeed Hakimi	Online webinar, May 2024
21	Workshop on 6G holistic radio design, in collaboration with Hexa-X-II and CENTRIC	Gilberto Berardinelli	Workshop EuCNC 2024

22	Workshop proposal on Short range extreme communication, in collaboration with TIMES and TERRAMETA	Gilberto Berardinelli	Workshop proposal EuCNC 2024
23	Presentation introducing the 6G-SHINE project and activities	Gilberto Berardinelli	Presentation at the EuCNC 6G series workshop by Hexa-X-II
24	On the road to dependable communication	Frank Burkhardt	Presentation at CWC, University of Oulu, June 2024
25	Overview of the latest project activities and achievements in the plenary session of 8th Technical Meeting of COST action INTERACT in Helsinki	Vittorio Degli Esposti	COST INTERACT in Helsinki, June 2024
26	Workshop on "Towards THz communication" , in collaboration with TIMES	Gilberto Berardinelli	Workshop at EuMW 2024, September 2024
27	Invited presentation "Architecture Enablers for 6G Subnetworks: The 6G-SHINE Vision"	Baldomero Coll-Perales	Hexa-X-II Workshop on Architecture and Standardization, October 2024
28	Presentation on Beyond 5G URLLC services: an enhanced configured scheduling solution	C. Tsakos and F. Foukalas	Training School and Research Colloquium: to https://nextgcom.iee.ihu.gr/index.html, October 2024
29	Second webinar introducing the AI/ML challenge on in-X subnetworks	Saeed Hakimi	Online webinar, October 2024

30	Distinguished speaker on “Self-conjugating metasurfaces for communication and sensing”, London (UK), 22 Nov. 2024	Davide Dardari	IEEE ComSoc 2024 Workshop on Emerging 6G Technologies, November 2024
31	Webinar on sustainable wireless design	Gilberto Berardinelli	Joint 6G-SHINE/SUPERIOT/TERRAMETA webinar, November 2024
32	Presentation on Wireless subnetworks and their enablers	Frank Burkhardt	ETFA Conference, December 2024
33	Invited Presentation	Baldomero Coll-Perales	Presentation of 6G-SHINE at SNS JU Architecture WG
34	Special session on Key enablers for integrated sensing and communications in industrial environments	Davide Dardari	Special session at IEEE CSCN 2024
35	Demonstration of a centralized radio resource management solution for inter-vehicle subnetworks.	Pedro Maia de Sant Ana	Bosch Automotive Ethernet conference 2024
36	Talk entitled “Multifunctional EM signal processing using Dynamic Scattering Arrays”, by Davide Dardari (CNIT)	Davide Dardari	One6G Open Lecture 10 on “Electromagnetic Signal and Information Theory (ESIT)”, April 30, 2025. https://one6g.org/events/open-lecture-10-electromagnetic-signal-and-information-theory/
37	Presentation on Dependable	Frank Burkhardt	Winter School Ruka, February 2025

	communication and its enablers		
38	TPC co-chair of the "7th International Workshop on Electromagnetic Signal and Information Theory workshop", Montreal, Canada	Davide Dardari	IEEE ICC 2025
39	Workshop presentation : " Energy efficiency aspects from PA models to AR/VR applications in Hexa-X-II and 6G SHINE projects."	Meng Lee	IEEE EuCNC 2025
40	Presentation on Das Dreigestirn Determinismus, Funk und Produktion	Frank Burkhardt	Presentation at Hannover Fair, April 2025
41	Presentation on Drahtlose Kommunikation in Maschinennähe	Frank Burkhardt	Presentation at Verein Deutscher Werkzeugmaschinenhersteller - Forschungsinstitut Arbeitskreis 5, April 2025
42	Keynote: Subnetworks in 6G	Frank Burkhardt	9th annual VTT demo day, April 2025
43	Webinar on electromagnetic signal processing for next generation wireless networks	Davide Dardari	6G-SHINE/TIMES webinar on electromagnetic signal processing; May 2025
44	Joint TIMES/6G-SHINE/TERRAMETA workshop, online	Gilberto Berardinelli	TIMES/6G-SHINE/TERRAMETA workshop, May 2025
45	Second workshop on 6G holistic radio design, organized in	Gilberto Berardinelli	Workshop at EuCNC 2025

	collaboration with Hexa-X-II		
46	Presentation at the special session on "Value Approach of 6G: The Role of Key Value Indicators in Design and Societal Impact"	Gilberto Berardinelli	Presentation at special session at EuCNC 2025
47	Keynote "Deterministic Communications in the 6G IoTEdge-Cloud Continuum" given at the IEEE Workshop on Converged Communication, Computing, and Control for Next-Generation Cyber-Physical Systems (C4CPS), held with IEEE VTC 2025-Spring	Javier Gozalvez	IEEE Workshop on Converged Communication, Computing, and Control for Next-Generation Cyber-Physical Systems (C4CPS), June 2025
48	Third joint webinar on sustainable wireless design	Saeed Hakimi	Third joint 6G-SHINE/SUPERIOT/TERRAMETA webinar, June 2025

4 STANDARDIZATION

4.1 INTRODUCTION

This section describes the activities from 6G-SHINE aimed at impacting standards. 6G-SHINE is a low TRL project, dealing with the relatively young topic of subnetworks. Recent proposals advocating for subnetworks were made in 3GPP, although, and despite the good indications, these are not yet a main topic of research in a study item. The proposals observed aimed at introducing the concept of subnetworks and discussing the potential existing features in the 5G system, that could serve the introduction of subnetworks for 6G. Hence, a gap analysis has been conducted within the 6G-SHINE project. Due to this, the consortia led contributions had to focus on more fundamental aspects of the introduction of subnetworks. This resulted in a number of very focused, high impact contributions led out of 6G-SHINE in order to introduce subnetworks in standards, and their challenges. The details on the impact are given below, highlighting the fundamental and groundbreaking research material and concepts developed in this project.

With the strategic objective of introducing subnetworks into 3GPP, it was also essential to establish a strong dissemination plan across other standardization fora. This serves as a means to raise awareness within both research and industrial communities about the novelty, timeliness, fundamental challenges, and benefits associated with the development and integration of these technologies. Moreover, it highlights their strong connection to the proposed 6G-SHINE use cases, not only from a technical perspective but also in terms of creating business opportunities.

Additionally, emerging technologies in standards such as sensing and ISAC, in both 3GPP and ETSI, opened the door for opportunities to contribute to these bodies, utilizing the suitability of the 6G-SHINE use cases to these technologies.

The next subsections aim at describing this plan and its execution during the lifespan of the project, as well as illustrating the future standards contribution potential, based on foundational work developed and recorded by the 6G-SHINE consortium.

4.2 SUBNETWORKS TECHNOLOGIES ECOSYSTEM AND ROAD TO STANDARDS

At the outset of the project, subnetworks were considered analogous to a wireless local area network but operating within a radio environment with distinctive characteristics. Within 6G-SHINE, key technology components were envisioned to support subnetworks and enable their seamless integration with a parent 6G network. Over the course of the project, standards contributions from other companies also began to reference subnetworks, yet these proposals generally remained high-level, lacking detailed discussion of the main technical challenges or of how subnetworks could effectively interoperate with a parent 6G system. While this broader engagement was beneficial in raising awareness and increasing industry support for the concept, it was the 6G-SHINE-led contributions that played a decisive role in securing the introduction of subnetworks in 3GPP. These contributions stood out for their thoroughness and for the gap analysis they provided, highlighting the limitations of existing 5G systems in terms of subnetwork integration and support. This effort was spearheaded by Bosch, with significant support from Fraunhofer.

A key aspect related to subnetwork capabilities in 6G-SHINE was the end-to-end distributed compute fabric. This is one of the important innovations worked on by the consortium, that had inception already in bodies such as IETF, but not in ETSI or 3GPP. Once more, other companies used opportunities such as the last two 3GPP 6G workshops, held in Rotterdam in May 2024, and in Incheon in March 2025, to present the topic, raise awareness, and start discussions. Here, it was observed that 3GPP is not yet addressing the topic in a study item, but contributions related to compute fabric started those discussions. In ETSI ISAC ISG, however, a new WI (WI#5) was created beginning of 2025, exactly to study, develop, and leverage this fabric to be used in sensing.

Sensing became an emergent topic in standards and attracted substantial attention since the start date for 6G-SHINE. An ETSI ISAC ISG was created to deal with the topic, and 3GPP received significant number of contributions to include it in the workplan, also leveraged by the IMT-2030 vision, that included sensing as a major topic of standardisation for 6G. IDE has introduced the topic to the 6G-SHINE project, with contributions accepted ranging from use cases, as detailed below, to an architectural framework for sensing.

Finally, RIS has been a target of standards work in ETSI, in the ETSI RIS ISG, with contributions from IDE accepted. In 3GPP, collaborative work between Keysight, AAU, and CNIT, led to a major SI proposal in 3GPP.
As per the above, all the research and standardization topics are relatively new. Hence, they required more work to raise awareness and gain traction in standards. Aligned with this, 6G-SHINE provided its high impact contributions, presented in the next section.

It is worth to mention that project partners also contributed to the preparation for the 3GPP SA1 Workshop on IMT-2030 Use Case, Rotterdam, May 2024, by providing input on the alignment of the 6G-SHINE use cases with the Hexa-X-II reference use cases.

4.3 6G-SHINE LED KEY CONTRIBUTIONS ACCEPTED IN STANDARDS

The following is a list of contributions presented at standardization bodies, authored by members of the 6G-SHINE consortium.

Firstly, the concept of subnetworks had to be introduced. Bosch and Fraunhofer collaborated successfully, also with other external companies to have an in-vehicle subnetwork use case accepted as part of the 6G accepted use cases in 3GPP. This is contribution S1-252959, and it can be seen in section 11.10, “Use case on in-vehicle local communication”, of the 3GPP TR 22.870. which is a complete in-vehicle subnetwork use, containing useful design on its integration with a parent 6G networks. Figure 2 depicts the proposed in-vehicle subnetwork

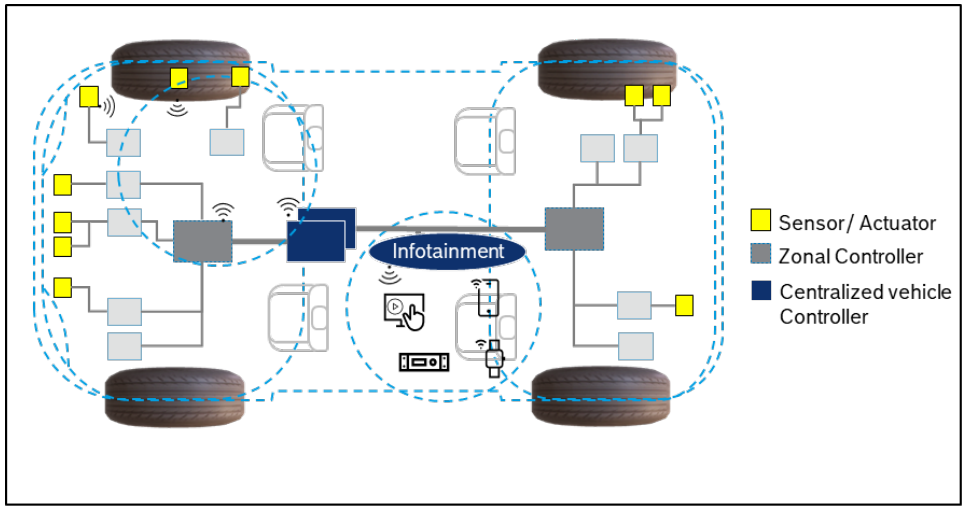

Figure 2 In-vehicle subnetwork accepted in 3GPP (S1-252959)

Moreover, this contribution has identified current features of Non-Public Networks (NPN), Sidelink, Personal IoT Networks (PIN) and Computing Power Network (CPN) technologies, that are relevant for the use case and goes to assert their insufficiencies in supporting at least partial autonomy of a subnetwork under the umbrella of the parent 6G network.

InterDigital (IDE) have proposed a use case on "emergency vehicle driving and route management" at the ETSI ISAC ISG which was accepted at the ISAC#003-plenary meeting in September 2024 (contribution ISC(24)000188). This is a use case addressing vehicles as subnetworks being fully integrated with a parent 6G network, and where sensing becomes a key enabler of the intelligent traffic management systems. Several gaps and new requirements were identified in this contribution for that aim, including aspects related to subnetwork integration, service continuity for mobile subnetworks (vehicles), leveraging the available 6G deployment and IoT fabric, AI/ML, and sensing. This use case was furthermore presented and is, at the time of writing this document, under discussion in 3GPP, and accepted at IETF as well.

The work presented by IDE in D2.4 related to architectural enablers for sensing has also been accepted at the ETSI ISAC ISG during ISAC#007-online in November 2024. Contribution ISC(24)000228r2 describes two new entities in the CN of the parent 6G network and their functionalities to enable sensing operations. This content and architectural work represents a foundation for enabling sensing related operations in subnetworks.

Sony has seen accepted contribution S1-242040, where 3GPP recognized the importance of working on immersive, massive, hyper reliable and low latency communications, in the context of use cases defined in 6G-SHINE such as the immersive education use case presented in 3GPP out of D2.1 and D2.2. This contribution was merged with other contributions and then later accepted after rounds of discussion that included information from this use case defined at early stages of the project.

Keysight and CNIT partnered together in the development and exploitation of new models for RIS-assisted scenarios. These models have been integrated with Keysight's hardware, and the company expects to leverage those for their measurement campaign-related equipment and products. When integrated with Keysight's hardware, the RIS macroscopic models developed by CNIT clearly show the

enhancement in radio coverage that can be achieved through effective planning of RIS-aided wireless communications scenarios. As a result, partners concluded that these tools represent significant advancements towards the integration of the RIS in 6G.

These five 6G-SHINE led contributions are very significant to the 6G work, for not only have they been subject to standards peer review and accepted, but they also represent the following project's achievements in standards:

- The concept of subnetworks was successfully introduced in 3GPP by 6G-SHINE
- Gap analysis of 6G-SHINE for the integration of subnetworks was validated in 3GPP
- A use case relating to in-vehicle subnetworks and sensing was accepted in ETSI and is now under discussion in 3GPP
- 6G architectural work related to Sensing was accepted in ETSI and 6G architectural enablers in 3GPP have 6G-SHINE involvement, notably in the sensing technologies, via this work
- Use cases out of 6G-SHINE are now part of the 3GPP 6G work, some fully, some partially, notably via 6G-SHINE contribution in 3GPP SA1 Workshop on IMT-2030 Use Case, Rotterdam, May 2024

Despite these achievements, there are other contributions worth mentioning that helped pave the way for the acceptance of the above.

4.4 OTHER 6G-SHINE LED CONTRIBUTIONS IN STANDARDS

The following is a list of contributions presented at standardization bodies, authored by members of the 6G-SHINE consortium. Rather than being accepted, these contributions were used to present topics and start discussions in standards. Therefore, they suffered alterations and refinements throughout the lifespan of the project, leading to the accepted documents listed above. Table 12 contains a list of these contributions, that does not include the list in the previous section.

Table 12 List of notable 6G-SHINE consortia led contributions to standards

Contribution title	Target SDO and WG	Target SI/WI	Meeting Name	Meeting Date	URL	Achieved Impact
3GPP Subnetworks in Rel-20: Motivation, Use Cases, and Proposal	3GPP SA1	New SI proposal	SA1#105	26-Feb-24	S1-240120	The Subnetworks study item document was presented in SA1. Official supporters grew by 2. Several companies suggested again that Subnetworks is a topic for 6G.
New Study on 3GPP Subnetworks	3GPP SA1	New SI proposal	SA1#105	26-Feb-24	S1-240265	Our Subnetworks proposal was presented and revisited for further discussion at the next meeting under the 6G topics
Vertical's view on 6G: 3GPP Subnetworks	3GPP SA1	New SI proposal	SA1#106	26-May-24	S1-241194	Relevance of subnetworks to IMT 2030 usage scenarios were shown. No strong objection against the topic (from technical point of view) was noted.
TP to RIS-004 on RIS deployment costs	ETSI RIS	DGR/RIS-004	RIS#13	18-May-24		Contribution related to deployment costs of the RIS
TP to RIS-004 on RIS device cost and complexity	ETSI RIS	DGR/RIS-004	RIS#13	18-May-24		Contribution related to cost and complexity considerations for he RIS
Discussion on Multiple RISs for Beamforming	ETSI RIS	DGR/RIS-004	RIS#13	18-May-24		Contribution related to beam forming in the presence of multiple RISs
The convergence of (computer) vision and (6G) communications	ETSI RIS	DGR/RIS-004	RIS#13	18-May-24		Contribution related to computer vision equipped Base Stations

Views on the SA1 6G Study	3GPP SA1	Rel-20 6G Presentations	3GPP SA1 Meeting #106	20-24 May 2024	S1-241014	Contribution related to the structure of 6G study and use-cases.
Views on the SA1 6G TR Structure	3GPP SA1	SA1	SA1#107	19-23 Aug -2024	S1-242040	Contribution related to the structure of 6G study, including to include hyper reliable and low latency communications.
Measurement-based characterization of D-band human body shadowing – brief description and link to Deliverable.	ETSI THz ISG	DGR/THz-003	THz#005	12-06-2023		This contribution presents measurement-based characterization of D-band human body shadowing with a focus on two aspects: signal attenuation and fading duration caused by human body blockage.
THz Transmitter Power Amplifier Modeling.	ETSI THz ISG	RGR/THz-003	THz#20	14 Nov 2024		Contribution related to PA modelling at THz
Joint AP and HMD Power Optimization of Sub-THz Virtual Realization	ETSI THz ISG	RGR/THz-003	THz#009	11 June 2025		Contribution on the presentation on EuCNC 2025
Wi-Fi8 coordinated spatial reuse feature	IEEE 802.11	New contribution	2025 May IEEE 802 Wireless Interim Session	13 May 2025	Presentation link	The contribution used openwifi as prototyping platform
Openwifi and sub-20 MHz Co-OFDMA	IEEE 802.11	New contribution	IEEE 802 Plenary Session	29th July 2025	Presentation link	Our work (coordinated OFDMA) is promoted towards all major industrial players, and we actively contribute to Wi-Fi standardization.

Subnetworks	5G-ACIA	New contribution	5G-ACIA Planning Workshop	10th of June 2025	N/A	Topic introduced in future topic list of 5G-ACIA

4.5 FUTURE 6G-SHINE LED CONTRIBUTIONS IN STANDARDS

Despite the very successful standards campaign, and as mentioned in the introduction, section 5.1, subnetworks have only recently been accepted. As a consequence, there is a significant part of the work developed under the project that has standards potential, but due to the current standards timeline, it was not possible for it to be presented yet but will be done in the future. This section highlights this work and its potential.

Network coding (TC8) was a topic under research by both IDE and Fraunhofer. Current specifications in 5G resort to techniques such as polar and LDPC codes. The work carried out in this topic was very significant for the project and future specifications, as the scalability in subnetworks and the use cases presented in D2.2 would greatly benefit from network coding advancements. There are no contributions to record from 6G-SHINE on this topic, but this is because 3GPP has not yet agreed to study it, despite good indications.

Cogninn spent significant time and effort in work related to AI/ML in subnetworks (TC12,TC13). AI/ML in 3GPP is an ongoing topic since 2021, and the researchers focused on guaranteeing standards compatibility in their work. Since there is not yet a dedicated study item to subnetworks, their work can be used in contributions to future releases, and Cogninn, despite not being an active standards contributor, reserves the plan to coordinate with partners in the future to present their work in standards bodies. In fact, Cogninn is a guest member of IEEE, and it plans to be member of 3GPP through ETSI membership and contribute to cognitive radio access technologies based on AI/ML progress within 6G-SHINE and beyond.

Connected Collaborative Computing (3C), or distributed compute fabric, is gaining significant interest as a key enabler of 6G networks. Existing work primarily focuses on leveraging 3C within the edge–cloud computing continuum. 6G-SHINE has introduced architectural enablers that extend this paradigm to include subnetworks as integral components of the IoT–edge–cloud continuum. Work developed by UMH in this context (TC10, TC15) has therefore potential for future standards presentation. In fact, architecture contributions associated with these TCs have been presented in workshops on standardization organized by Hexa-X II and are included in Hexa-X II deliverables. They are therefore likely to be used when SA2 starts discussing 6G architectures.

The work conducted in D2.4, D4.3 and D4.4 on how to integrate subnetworks into an umbrella 6G NW and how subnetworks are supposed to work in terms of radio resource management and quality of service guarantees (TC14, TC15, TC16) is essential to establish pathways for having subnetworks within 6G networks. These solutions have the potential for contributions for 3GPP standards as they describe impact on 3GPP-defined nodes and functionalities within the RAN as well as within the core network and can be taken as input for 3GPP study items.

Imec is planning to present the TC11 related work to ETSI ERM TG11 and BRAN WGs, targeting to influence the related ETSI standards (ETSI EN 300 328 and ETSI EN 301 893) so hard prioritization can be supported from any wireless technology in the context of basic medium access schemes enforced by these standards for 2.4GHz and 5GHz ISM bands. This change will enable real-time support for latency sensitive applications that today struggle when operating in shared bands, due to the impact of traffic

load to network performance because of statistical prioritizations schemes offered only by each technology.

Keysight plans to present the GSCM parameterization of the 3GPP TR 38.901 channel models for FR1, FR2, and FR3, targeting industrial and consumer short-range communication scenarios. In addition, Keysight will propose the integration of a RIS channel modelling component into the 3GPP TR 38.901 framework.

Multimodal communication (TC4) is expected play an important role for extended reality (XR) related use-cases. Sony plan to propose the technology enablers of multimodal communication for intra and inter subnetwork(s), including for both uplink and downlink traffic. The targeted standardisation body is 3GPP SA2 for system architecture and 3GPP RAN2 for radio protocol and signalling.

It is not possible for the consortia to quantify or to predict when there will be opportunities for standards contributions based on this work, but as final remarks it is worth pointing out both the significance of this work and its standards potential, and its volume, especially now that subnetworks are officially a part of 3GPP efforts.

5 EXPLOITATION

Exploitation was considered on the one hand as being an individual task of each partner of the project as each partner has its own individual plans to benefit from the project. On the other hand, there have some common exploitation goals have been identified that are followed by the overall consortium. Based on the planning at the beginning of the project the activities have been tracked and the planning extended to beyond the runtime of the project to provide information on the sustainability of the project's achievements in the context of exploitation.

5.1 INDIVIDUAL EXPLOITATION

In the following the individual already carried out exploitation and the plans beyond the runtime of the project are provided here on a per project partner level.

During the project lifetime, **AAU**'s dissemination efforts have positioned it at the forefront of academic research in short-range wireless communications. AAU has produced 11 journal papers and 15 conference papers that have already been accepted, with an additional 6 papers currently under review. These publications disseminate the work carried out in WP2, WP3, and WP4, covering topics such as radio propagation measurements and modelling, medium access control procedures to enhance latency and reliability in in-X subnetworks, and radio resource management techniques, including AI-based methods. Notably, 11 of these publications are joint works with other project partners. For example, several radio propagation and modelling papers were co-authored with CNIT and Keysight, radio resource management research was developed in collaboration with Nokia, and goal-oriented communication work was conducted jointly with Bosch. These collaborations have fostered new opportunities for ongoing academia–industry partnerships.
The publication record also includes a joint article outlining the 6G-SHINE project vision, authored by all partners and presented by the coordinator at the IEEE Future Networks World Forum in November 2023. AAU has further contributed to the scientific community by launching a new ITU Machine Learning Challenge focused on radio resource management in dense in-X subnetworks, providing open-source datasets and simulation code for the challenge.
In terms of outreach, AAU has been highly active in conferences, industry fora, and webinars, delivering 14 invited talks (including 2 keynotes) that presented the project's scope and results. Within the SNS JU ecosystem, AAU has maintained strong visibility by organizing joint activities with other SNS projects (TIMES, CENTRIC, TERRAMETA, SUPERIOT, Hexa-X-II). A notable example is the workshop series on 6G Holistic Radio Design, launched in 2024 in collaboration with Hexa-X-II at EuCNC 2024, and held again at EuCNC 2025. Other relevant examples are the workshop on short-range radio propagation organized with TIMES for the European Microwave week 2024, and the series of webinar organized together with SUPERIOT and TERRAMETA, that reached a third edition in June 2025.
AAU has also actively contributed to SNS Task Board (TB) activities, serving as a section editor for the white paper on Sustainability in SNS Projects, and contributing to the SNS Machine Learning and Architecture white papers.
Finally, AAU has initiated a Special Issue on 6G Local Area Networks for *IEEE Wireless Communications Magazine*, which has attracted several high-quality submissions from around the world and will be published in October 2025.
AAU plans to capitalize the great knowledge, academic records, and networking built during the project lifetime by kicking-off the preparation of further collaborative projects, at both national and European

level. This will ensure that AAU will maintain a leading position in the area of short-range wireless communications.

Nokia has developed and protected seven patents related to In-X subnetworks and co-authored three conference papers—for EUCNC 2024, VTC-Fall 2024 and EUCNC 2025. In terms of standardization activities, Nokia has been actively monitoring standardization bodies such as 3GPP and the pre-standardization body Next-GA for dissemination opportunities related to 6G-SHINE. Nokia has participated in discussions, reviewing and commenting on partner contributions to 3GPP. Nokia plans to propose subnetworks in relevant standardization bodies and to use the findings from the project to promote the use cases as well as technical enablers.

Through its participation in 6G-SHINE, **UMH** has significantly strengthened its research positioning in the domain of connected and automated mobility, with a particular focus on (in-vehicle) subnetworks and their integration into the 6G parent network as part of the IoT-edge-cloud continuum. UMH has actively disseminated its scientific results from WP2, WP3, and WP4 through six publications in well-reputed IEEE conferences, including IEEE VNC, IEEE VTC2025-Spring (2 papers), IEEE ISCC (2 papers), and IEEE/CIC ICCC 2025; UMH also co-authored 1 conference paper on the 6G-SHINE vision at the IEEE Future Networks World Forum. Additionally, one journal article has been submitted to the IEEE Internet of Things Journal and is currently under review. WP4 research outcomes also formed the basis of a keynote presentation at IEEE VTC2025-Spring's Workshop, demonstrating the visibility and relevance of UMH's contributions. UMH's leadership in WP2 has translated into substantial impact at the European level. UMH has represented the project within the SNS JU Architecture Working Group, contributing directly to two white papers produced by the group. Moreover, UMH presented 6G-SHINE's WP2 results (mainly use cases and architecture) in the "Workshop on 6G Architecture and Standards," organized by the Hexa-X-II European flagship initiative. UMH has also led and edited the development of a 6G-SHINE's white paper on "Architectural Enablers for 6G Subnetworks and Integration into 6G Network of Networks: The 6G-SHINE vision" and is currently finalizing a joint journal article summarizing the WP2 architectural blueprint, which will be submitted to the IEEE Internet of Things Journal. As part of its contribution to WP2 use case definition, UMH led the work on in-vehicle subnetworks, which was presented at the 3GPP SA1 Workshop on Stage 1 IMT-2030 (6G) Use Cases. This work helps shape standardization discussions on the role of subnetworks in future connected mobility scenarios. UMH has also advanced capacity building through research training. One PhD student has been directly trained through WP3 activities on prediction-based radio resource allocation for in-vehicle networks. Additionally, a second PhD student is leveraging the same methodologies within the context of industrial networking, demonstrating cross-domain transfer of project knowledge. UMH is leading the organization of a Special Issue (IDE is also part of the Guest Editorial board) currently under evaluation by the IEEE Network journal, expected to be published in May 2026. This initiative is aimed at promoting areas of high significance for 6G-SHINE. To promote open research and community engagement, UMH has released a publicly available dataset on in-vehicle network traffic. This dataset was generated using the unique Connected and Automated Mobility (CAM) platform that integrates CARLA's realistic 3D simulation environment with the Autoware autonomous driving software stack. The dataset covers the in-vehicle network traffic associated with perception, localization, planning, and control functionalities. Part of this dataset has already been exploited to model and predict network traffic patterns, with the goal of supporting deterministic service delivery in future vehicular networks.

The 6G-SHINE project allowed **IDE** to explore innovation opportunities in the short-range and heterogeneous system domains, with ISAC in V2X scenarios as a particular technology angle. IDE exploited the technology developed during the lifetime of the project by directly impacting ETSI ISGs, i.e. ISG ISAC and ISG RIS. The technologies that IDE created within 6G-SHINE project were disseminated to these standardization bodies, whilst increasing the company's licensing opportunities to device and network manufacturers. IDE also leveraged the developed PoC to showcase ISAC at the company's booth at Mobile World Congress 2025. Moreover, IDE significantly benefited from the wide-range of expertise that were available in the 6G-SHINE consortium, i.e. from system integrators to device manufacturers, that will allow the company to broaden its knowledge base and also provide additional market and technology development opportunities.

Throughout the project and as a consumer electronics and entertainment company, **Sony** has explored the prospective use-cases that can be benefited from the involvement in 6G-SHINE. This is in line with Sony's purpose to fill the world with emotion, through the power of creativity and technology. Furthermore, we have also developed numerous technology solutions in various 6G-SHINE work packages/tasks to support our use-cases. The work resulted in several patents and an IEEE conference publication (ICC 2024). Sony has been actively engaged in the standardisation bodies and industrial consortium, particularly 3GPP. During the project, Sony has submitted contributions to 3GPP SA1 to promote 6G-SHINE use-cases and its requirements as a potential 6G use-cases. Additionally, Sony has also actively engaged in the discussion and reviewed the project partner's contributions. Apart from 3GPP SA1, Sony has monitored the relevant activities in other working groups, such as SA2, RAN1, RAN2, and RAN4. We plan to promote the developed technology solutions/enablers to such 3GPP working groups at the appropriate time.

As an institution for applied research, **Fraunhofer IIS (FHG)** exploited the results of the project on the scientific side as well as on the commercial side. On the scientific side the findings have been presented at relevant conferences (EuCNC, 6G-platform, ETFA) and individual events (presentation at CWC, Delta Winterschool). Further publications of the final project results are currently planned.
This was and is done to enhance IIS scientific profile and build the basis for further advanced research topics as well as follow-up research activities. It was flanked by supporting the successful introducing of the project's findings at 3GPP SA1, which was led by Bosch. By that the results may become relevant for the concrete 6G-technology development, enhancing the currently existing standards. This will require future work of bringing the topic from SA1 to RAN level, where the actual definition of the technical realization would be done. By this the option of licensing the two identified and filed IPRs of FHG is strengthened. Finally based on its PoC, FHG is able to showcase the benefit of its technological components, allowing them to be considered and incorporated into available and future industrial RATs. Finally, IIS is incorporating the concept of subnetworks into its future research roadmap and considers it a relevant topic for the upcoming years, trying to initiate further enhancements of the current state in national and international public funded projects.

Keysight has extensively leveraged the project outcomes, particularly from WP2 and WP5. Most importantly, the project enabled Keysight to develop a new commercial low-latency PROPSIM channel emulator platform that delivers a 73% improvement over the legacy emulator. This breakthrough directly supports in-X subnetwork use cases. In addition, Keysight utilized radio channel measurement data generated within the project to perform GSCM parameterization of the 3GPP channel model for industrial and outdoor consumer network scenarios across the FR1, FR2, and FR3 frequency bands. RF

material measurements at FR3 were also exploited to characterize reflection and scattering properties, providing valuable input for deterministic channel modelling solutions such as ray tracing. These were demonstrated with PROPSIM channel emulator at EUCNC 2024. Furthermore, Keysight integrated the RIS channel model developed in the project into the PROPSIM channel emulation solution and successfully showcased it at EUCNC 2025. Two scientific papers have already been published on these topics. Finally, Keysight contributed to pre-standardization efforts by submitting input to ETSI THz ISG on a human-blockage-inclusive channel model for THz frequencies.

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IMEC has exploited the results achieved in this project in multiple approaches. First, as a research institute, we published on high impact conferences such as IEEE INFOCOMM and EuCNC, and journals such as Ad Hoc Networks. Secondly IMEC has been following up IEEE 802.11 standardization activities, ETSI THz group activities and made pre-standardization contribution, based on the knowledge we accumulated during the 6G-SHINE project. Thirdly, several technology components in this project are now part of the openwifi subscription model. Apart from the free opensource repository, users interested in advanced features can thus choose to pay a licensing fee in order to unlock certain features, more details please refer to the website https://openwifi.tech/subscriptions/openwifi. In the future, IMEC will keep using the technology components of 6G-SHINE, maintain its development on the openwifi subscription website, new publication may also be produced given fitted subject and collaboration opportunities. Further standardization actions will take place within ETSI related to ISM band rules access. Lastly, part of the IP created within 6G-SHINE will be employed in a valorisation effort within IMEC to spinoff a company that will focus on wireless industrial applications.

As a scientific institution, **CNIT** has mainly exploited the results through the publication of several papers to international journals such as IEEE Trans. Wireless communications, IEEE Trans. on Communications, IEEE Communications Standards Magazine, IEEE Trans. on Antennas and Propagation, IEEE Open Journal of Antennas and Propagation, and conferences such as the International Conference on Communications, and European Conference of Antennas and Propagation. CNIT was the editor and contributor of the chapter “6G Transceiver and radio design” of the book "6G to Build a Sustainable Future", Wiley, edited by Hexa-X-II.
CNIT has been active in organizing workshops in collaboration with the SNS projects TIMES and TERRAMETA (Joint SNS TIMES/6G-SHINE/TERRAMETA workshop, also in synergy with the Italian project RESTART-IN, Bologna, 2024, EuCNC 2024 on “Short range extreme communication”, EuMW 2024 on “Towards THz communication: implementation and propagation challenges in harsh environments”), and other international workshops and special sessions (e.g., 7th Workshop on Electromagnetic Signal and information Theory at ICC 2025, IEEE CSCN 2024 on Key enablers for integrated sensing and communications in industrial environments). CNIT was the organizer of the URSI-EMTS conference held in Bologna in June 2025, where the project activities carried out in 2024 have been disseminated.
CNIT has delivered several webinars and keynotes: One6G Open Lecture 10 on “Electromagnetic Signal and Information Theory (ESIT)”, April 30, 2025. Talk entitled “Multifunctional EM signal processing using Dynamic Scattering Arrays”, talk “Self-conjugating metasurfaces for communication and sensing” at the IEEE ComSoc 2024 Workshop on Emerging 6G Technologies, London, 2024, keynote on “Holographic communications: When electromagnetism meets signal processing” at the Workshop on Holographic MIMO Communications, ICC 2023, 6G-SHINE/TIMES webinars on “Electromagnetic signal processing for next generation wireless networks” and on "Macroscopic ray based modelling of scattering from

Reconfigurable Intelligent Surfaces", talk on “Modelling of radio propagation in harsh environment” at EuMW 2024.
CNIT organized the course on “Short Range Propagation” of the European School of Antennas and Propagation (ESoA) held in Cesenatico in September 2023. The course was an official dissemination event for the 6G-SHINE project, with a demo presented by Keysight on channel sounding at sub-THz frequencies.
CNIT created and made publicly available on the Zenodo repository of the project several datasets on propagation measurements, implementations of macroscopic models for RIS, and synthetically generated channel data obtained with the help of ray tracing simulations. CNIT collaborated with the CENTRIC project for the implementation of macroscopic models for RIS in the open-source simulator Sionna Ray Tracing, and with Keysight where coverage simulations for RIS-assisted wireless communications scenarios have been integrated into the Keysight’s hardware emulator.
CNIT established a liaison with the EU COST Action CA20120 INTERACT and disseminated the main project results during the INTERACT scientific meetings.
CNIT is proposing a Workshop at EuCNC 2025 in collaboration with the SNS projects TIMES and TERRAMETA. It is involved in the organization of the EuCAP 2026 Conference in Dublin, where the project activities of 2025 will be disseminated, and has submitted the feature paper “An Overview on Over-the-air Electromagnetic Signal Processing”, to IEEE Signal Processing Magazine. Moreover, CNIT is currently working with Keysight to integrate macroscopic RIS models into Geometric Stochastic Channel Models (GSCM), for possible standardization in the ETSI/3GPP framework.

Bosch has actively promoted the in-X subnetworks topic within the 3GPP Technical Specification Group Service and System Aspects (TSG SA-1), which is responsible for considering and studying new and enhanced services, features, and capabilities, and for identifying corresponding stage 1 requirements for 3GPP specifications. A use case derived from 6G SHINE WP2 was successfully approved in 3GPP SA-1, enabling us to advance this topic to the downstream working groups. Additionally, in collaboration with Aalborg University, Bosch has contributed to the academic community by co-authoring two papers presented at major IEEE conferences and one journal article published in the prestigious IEEE Journal on Selected Areas in Communications (JSAC), based on work carried out in WP2, WP4, and WP5.

Apple will use the findings from this project to support its ongoing wireless technology development, which will be used in its diverse portfolio of commercial product offerings enjoyed by many millions of consumer end users around the world. Furthermore, Apple has presented 3 publications to scientific events over the course of this project. “Boosting Short-Range Wireless Communications in Entities: the 6G-SHINE Vision”, published in 2023 in the IEEE Future Networks World Forum (FNWF), “Subnetworks: A Novel Architectural Paradigm for 6G” published in 2025 at Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit) and “Distributed Compute Offloading in Local Communications”, published in 2025 at International Conference on Computing, Networking and Communications (ICNC).

COGN plans to develop 6G subnetworks and demonstrate them to industrial forums and investors to attract funding for further development of ultra-reliable and latency subnetworks for vertical applications. COGN is working on different radio access technologies, addressing similar challenges like those of 6G subnetworks, especially those considering URLLC in unlicensed bands. Another exploitation element of COGN research is AI-enabled wireless access, which is one of the major technologies developed within its own lab. To this end, COGN has demonstrated an AI enabled RRM solutions for 6G

subnetworks at EuCNC'25 including the associated paper presentation. COGN was also awarded a best paper award at IEEE CSCN'24 with a paper about link adaptation for configured grant in 6G subnetworks.

5.2 JOINT EXPLOITATION

Joint exploitation was targeted in two directions. On the one hand 6G-SHINE targeted 6G pre-standardization activities; on the other hand, the development-of an 6G ecosystem for future collaboration on a mid- to long-term range. The intention of the first was to set up the ground for the incorporation and deep integration of subnetworks in the 3GPP standards allowing an exploitation of the achieved research results. The plan for the second was to establish a network of partners that allows to bring the projects results forward on the road of development from the initial PoCs to future real-world applications.

During the project SNS-JU and 6G-IA started new working groups which have been adapted by the project, being considered equivalent to the impact that can be generated in other prestandardization bodies. An overview of the partners involvement in SNS-JU working groups and 6G-IA working groups are provided in Table 13 and 14 respectively.

Table 13 SNS-JU Working Groups

SNS-JU	
Working group	**Contributing Partners**
Architecture WG	Bosch, UMH, IDE
Sustainability task force	AAU
Test Measurement and Validation WG	AAU
Hardware WG	IMEC, COGN

Within the Architecture WG, we have shared our vision for integration of in-X subnetworks in the 6G 'network of networks' via dedicated presentations in the group meetings as well as in their organized online workshop. We also contributed to the architecture whitepaper organized by the WG. In summary, we have influenced the shaping of the 6G architecture vision by bringing our short-range subnetwork concepts.
Our contribution to the Sustainability task force was also major. We contributed to the team that has processed the results of the interviews of SNS projects taken by the task force leader, in order to extract common learnings and trends, and significantly contributed to the released whitepaper by taking section editor roles and contributing to the writing.
The Hardware WG was only established in 2025 and therefore there was not much opportunity for meaningful contributions, besides joining the relevant telcos.
We have also joined the Test, Measurement and Validation WG only in Spring 2025, and contributed to the discussions related to KPIs for IMT-2030.

Table 14 6G-IA Working groups

6G-IA	
Working group	**Contributing Partners**
Pre-standardization WG	IDE
Vision and societal challenges WG	AAU

In the pre-standardization WG, we have periodically reported the status of our activities in standardization bodies. Also, we have co-organized with TIMES and TERRAMETA a special session on short-range communication at IEEE CSCN 2023 and 2024.
We have contributed to the Vision and societal challenges WG by raising awareness of the challenges of addressing aspects related to social, economic and environmental sustainability in low TLR projects, and proposing way forwards for addressing this aspect. We contributed to a special session organized at EuCNC 2025 with a presentation on how to address sustainability in low TRL projects.

Besides our participation in SNS and 6G IA WGs, we have been very active in the SNS steering board and technical board. We have 100% attendance rate of telcos and in-person meetings and significantly contributed to discussion and common actions during the project lifetime.

In addition to that the project partners were active in prestandardization organizations and provided their contributions as it was shown in Table 12.

What was visible throughout the pre-standardization organizations is that 6G is currently not largely pushed by the operating industries as the commercialization of 5G is still a focus of many members of these organizations. Therefore, the topic of subnetworks was presented officially (e.g. in 5G-ACIA) or on an informal level at some of them but the feedback regarding priority of the topic of 6G and subnetworks was rated rather low in regard to their working process.

5.3 NEXT STEPS IN EXPLOITATION

Based on the exploitation that was already done the project partners are planning to take the next joint steps into the future. The goal is to take the topic of subnetworks to the next level. This means that, from the discovered individual technology component and the associated PoCs, a road the integration of these components into a future 6G system is provided. This contains the following aspects:

- Continuous communication and dissemination of project results
    - The dissemination of the final achievements of the project is continued at conferences, in journals, the second special issue, pre-standardization, standardization and in presentations at various occasions (scientific, industrial, political audience). Also, these achievements will be further shared on the established communication channels. With this we ensure that all the latest achievements reach the stake holders of interest.
    - Continuation of work in pre-standardization and standardization to ensure that the input provided there is followed on upon and that the topic of subnetworks and the achievement of the technology components development is moving forward through the standardization process. This means that for example the contributions to 3GPP SA1 are taken forward to discussion at RAN level
- Preparation of project continuation. The project achievements are taken as the baseline for future research project proposals. This will be done individually as described in the individual exploitation section but also in a common way, where the big picture can be addressed in which multiple technology components are combined to form a common 6G system.

The roadmap for these steps is provided in the Figure 3.

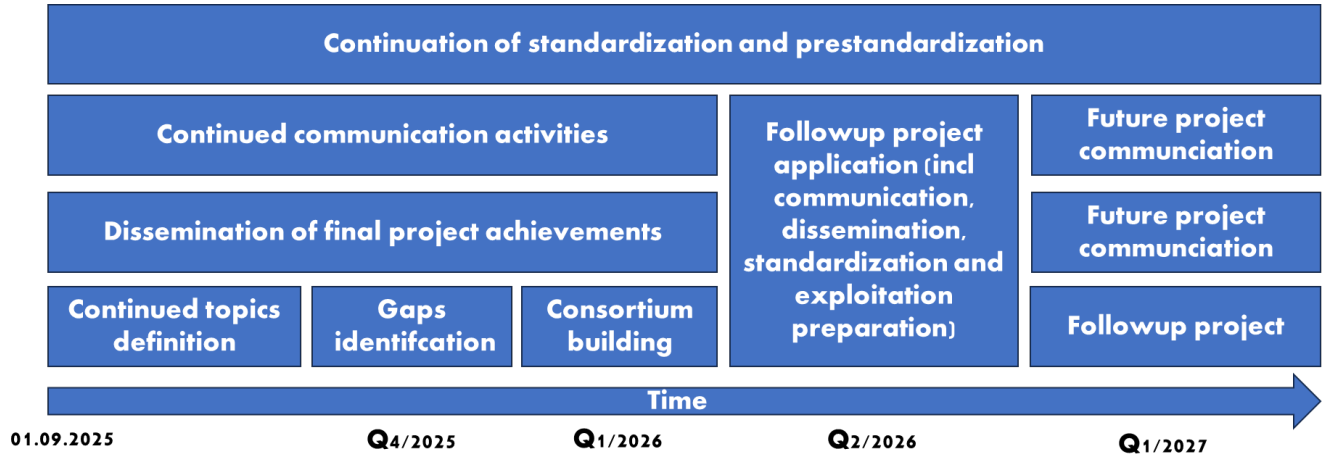

Figure 3 6G-SHINE follow-up exploitation roadmap

The figure shows the timeframe after the end of the project 6G-SHINE. As can be seen communication and dissemination of the final results is still ongoing while the topics that shall be continued in a follow-up project are defined, the gaps in the consortium to achieve the follow-up goals are identified and finally a revised and enhanced consortium is built. After that the new project is applied for and under the assumption that the application is successful the communication, dissemination and research continue within the frame of the new project.

5.4 IPRS

One special topic of exploitation is the provision of IPRs. As associated IPRs those IPRs are considered that have been submitted during the runtime of the project and are concerned with the topics of the project. It was planned to submit at least 20 IPRs during the course of the project, creating a sound basis for licensing-based exploitation models. The details of the IPR have not been disclosed publicly, but only their topics. The list of IPRs related to the project is as follows.

Table 15 List of IPRs (status 28.08.2025)

Nr.	Title	Priority Date	Author	Priority Application	Priority Country	Related Application Number	Related Publication Number	Publication Date
1	Effizientes Vorwärtsfehlerkorrekturverfahren für Echtzeit-Funksysteme	10.03.2023						
2	Methods, infrastructure equipment, and communications devices	27.06.2023						
3	Method, Apparatus and Computer Program	29.06.2023						
4	Determination of a location parameter for a user equipment	18.08.2023						
5	Methods for enabling positioning of a wireless device, related nodes and a related wireless device	19.09.2023						
6	Graph-learning sub-band allocation	11.10.2023						
7	A sub-network frequency band selection procedure	15.12.2023						
8	Sub-network bands determination	27.12.2024						

9	A method for agc adjustment in 6G sub-networks	20.01.2024						
10	Resource allocation	08.02.2024						
11	A method for determining one or more beams	10.07.2024						
12	Sub-network registration	19.12.2024						
13	Verfahren für opportunistische Network Coded Cooperation in URLLC-/HRLLC-Funksystemen	22.05.2025						
14	METHODS FOR LEVERAGING RATING INFORMATION FOR CUSTOMIZING LTM MOBILITY WITH SERVICE SPECIFIC PREFERENCES FOR DEVICES IN A CLUSTER	6-Jul-23	Ognenoski, Ognen; Martin, Brian; Conceicao, Filipe; Mourad, Alain; Kulkarni, Milind	63/525,202	US	n/a	n/a	n/a
15	METHODS FOR LEVERAGING RATING INFORMATION FOR CUSTOMIZING LTM MOBILITY WITH SERVICE SPECIFIC PREFERENCES	6-Jul-23	Ognenoski, Ognen; Martin, Brian; Conceicao, Filipe; Mourad, Alain; Kulkarni, Milind	63/525,194	US	PCT/US2024/036749	WO2025010343	09-Jan-25
16	METHODS FOR LEVERAGING RATING INFORMATION FOR CUSTOMIZING LTM MOBILITY WITH SERVICE SPECIFIC PREFERENCES	14-Jul-23	Ognenoski, Ognen; Rao, Jaya; Marinier, Paul; Negusse, Senay; Teyeb, Oumer;	63/526,692	US	n/a	n/a	n/a

			Lutchoomun Tejaswinee; Mostafa, Ahmed					
17	METHODS, ARCHITECTURES, APPARATUSES AND SYSTEMS FOR MANAGING EXTENDED REALITY TRAFFIC TRANSMISSIONS	14-Jul-23	Ognenoski, Ognen; Rao, Jaya; Marinier, Paul; Negusse, Senay; Teyeb, Oumer; Lutchoomun Tejaswinee; Mostafa, Ahmed	63/526,691	US	PCT/US2024/038029	WO2025019417	23-Jan-25
18	Methods and Apparatus for Beam Management in a Wireless Transmit/Receive Unit Using AI/ML	7-Aug-23	Conceicao, Filipe; Tooher, Patrick; Lutchoomun, Winee; Miller, James; Teyeb, Oumer; Deenoo, Yugeswar;	63/531,253	US	PCT/US2024/040351	WO2025034487	13-Feb-25
19	Methods and Apparatus for Evaluating Performance of an AI/ML model for Predicting Beam Management Parameters in a Wireless Network	7-Aug-23	Conceicao, Filipe; Tooher, Patrick; Lutchoomun, Winee; Miller, James; Teyeb, Oumer; Deenoo, Yugeswar;	63/531,254	US	PCT/US2024/040354	WO2025034488	13-Feb-25
20	Methods and Apparatus for Determining an Input	7-Aug-23	Conceicao, Filipe; Tooher,	63/531,269	US	PCT/US2024/040357	WO2025034489	13-Feb-25

	Dataset for an AI/ML Model for Predicting Beam Management Parameters in a Wireless Network		Patrick; Lutchoomun, Winee; Miller, James; Teyeb, Oumer; Deenoo, Yugeswar;					
21	METHODS, ARCHITECTURES, APPARATUSES AND SYSTEMS FOR PACKET DATA CONVERGENCE PROTOCOL ROUTING ENHANCEMENTS FOR NETWORK CODING PROTOCOL DATA UNITS	30-Aug-24	Ijaz, Ayesha; Freda, Martino; Alfarhan, Faris; Adjakple, Pascal; Pelletier, Benoit; Pelletier, Ghyslain; Almradi, Ahmed; Elhoushy, Salah; Cray, Justin	18/820,767	US	PCT/US2025/043298	n/a	n/a
22	ENHANCEMENTS ASSOCIATED WITH PACKET DATA CONVERGENCE PROTOCOL NETWORK CODING	29-Mar-24	Ijaz, Ayesha; Cray, Justin; Elhoushy, Salah; Alfarhan, Faris; Adjakple, Pascal; Pelletier, Ghyslain; Marinier, Paul; Pelletier, Benoit	63/571,755	US	PCT/US2025/022018	n/a	n/a
23	METHODS, ARCHITECTURES, APPARATUSES AND	20-Jun-24	Ognenoski, Ognen; Hasegawa, Fumihiro;	18/749,294	US	PCT/US2025/034273	n/a	n/a

	SYSTEMS FOR POWER SAVING SENSING		Stern-Berkowitz, Janet; Pelletier, Ghyslain; Koirala, Remun; Marinier, Paul; Deng, Tao; Salim, Umer; Lee, Moon IL; LaSita, Frank; Shah, Kunjan					
24	METHODS, ARCHITECTURES, APPARATUSES AND SYSTEMS FOR SENSING	3-Jul-24	Ognenoski, Ognen; Conceicao, Filipe; Mourad, Alain; Lorca Hernando, Javier; Mestrah, Yasser; Shojaeifard, Arman; Heggo, Mohammad; Jadoon, Muhammad Awais	18/763,254	US	PCT/US2025/036102	n/a	n/a
25	"METHODS, ARCHITECTURES, APPARATUSES AND SYSTEMS FOR HANDLING SENSING COVERAGE FAILURE EVENTS IN WIRELESS SYSTEMS"	23-May-25	Conceicao, Filipe; Babu, Abinaya; Robitzsch, Sebastian; Bhatia, Laksh; Jadoon, Muhammad Awais; Olvera-	19/217,532	US	n/a	n/a	n/a

			Hernandez, Ulises					
26	METHODS, ARCHITECTURES, APPARATUSES AND SYSTEMS FOR DETECTING AND RESPONDING TO SENSING OUTAGES	15-Nov-24	Jadoon, Muhammad Awais; Conceicao, Filipe; Mourad, Alain	18/949,820	US	n/a	n/a	n/a

As can be seen an overall of 26 IPRs have been filed, exceeding the planned KPI of the project, i.e., 20. This underlines that with the conducted research valuable intellectual property was derived.

6 CONCLUSION

This report has shown that the communication, dissemination, exploitation and standardization planning for a project are mandatory and worthwhile to go through. With a good planning basis the activities can be tracked, deviations can be identified and countermeasures taken. With this the best possible public reception of the project results is supported.

The success in dissemination, which means that in general more dissemination was done than planned, although the planned dissemination was not too modest, shows that the projects goals have been valid, the research questions hit the spot, that the results sparked a large interest in the different communities and that there is the potential to do lot more of research in this area .

Regarding standardization the project has achieved to take initial hurdles with successful contributions to different standardization groups and presenting the topic also in pre-standardization fora. Here it can be clearly seen that there will be a lot of effort required to keep the topic present in these groups and push it from these initial stags to full blown standardization activities, which means work items in the relevant groups.

In the exploitation area the project provides an excellent basis for further scientific research and a continuation in future projects which are backed by the identified IPRs which underline that we pushed the boundaries of knowledge within the project and provide the basis for an individual future exploitation of the achieved results for the respective partners.

Overall, this clearly shows that the topic is really relevant and gives a good indication that this road is more than worthwhile to be followed further. This will either be done individually and/or a common basis to make sure that 6G becomes the best 6G that is possible and will include support for in-X subnetworks.