RESTART Foundation WG on Satellite Technologies for Communications

Scope and Areas of Work

The Working Group addresses the evolution of satellite technologies for communications and their integration with terrestrial networks, focusing on Italian and European research, technological trends, industrial interests, and the institutional ecosystem.

Its activities are organized into three Areas of Work: (1) Technology, Research and Standardization and Interoperability, (2) Regulation, Industry, Market and Ecosystem, and (3) Strategic Coordination and Cooperation.

The Group will investigate key technological, standardization, regulatory, industrial and market developments, identify emerging challenges, opportunities and gaps, and assess their potential impact on future communication systems and services. It will also promote coordination across RESTART and cooperation with external stakeholders, including universities, research centers, industries, operators, institutions, research programs and standardization bodies.

Planned outcomes include periodic reports and strategic analyses; workshops and expert forums; identification of collaboration and funding opportunities; contributions to standardization, regulatory, and policy discussions; and recommendations or roadmaps supporting future research, innovation, and industrial and institutional initiatives.

Mandate, Purpose and Objectives

Satellite communications are gaining renewed strategic relevance, driven by the rapid development of LEO constellations, Non-Terrestrial Networks (NTN), direct-to-device services, and the progressive integration of satellite and terrestrial network infrastructures towards future 6G communication systems.

The Working Group is established to provide the RESTART community with a stable and cooperative forum for monitoring, analysis, discussion and coordination of this evolution. Its purpose is to bring together complementary academic, industrial and institutional perspectives, foster the exchange of knowledge, experiences, requirements and best practices, and support a shared understanding of the

technological, industrial, market, regulatory and strategic developments affecting satellite communications.

The overall mandate of the Working Group is to monitor and assess relevant trends, identify emerging challenges, opportunities and strategic developments, foster collaboration and synergies among RESTART partners and between academic and industrial communities, identify opportunities for joint initiatives, technology transfer, standardization, innovation and industrial cooperation, and support, where appropriate, the development of common positions, recommendations, roadmaps and strategic orientations.

The mandate is implemented through three Areas of Work.

AoW #1: Technology, Research, and Standardization

This Area of Work monitors the evolution of satellite communication technologies, architectures, networking, tools, research trends, standards and interoperability requirements.

Key question: How are satellite communication technologies and standards evolving, and which developments are most relevant for the RESTART ecosystem?

Main activities include:

- GEO, MEO, LEO and multi-orbit communication systems and networks;
- 5G/6G NTN and integration of terrestrial and non-terrestrial networks;
- direct-to-device communications, inter-satellite links and advanced payloads;
- multi-dimensional resource allocation in NTNs;
- reconfigurable metasurfaces for satellite payloads and ground/user terminals
- low-profile, low-power electronically steerable reflectarrays/transmitarrays with frequency- and polarization-agile apertures
- multifunctional surfaces (anomalous reflection, absorption, filtering) tuned by lumped components, graphene/2D and phase-change material
- digital twins and AI-enabled modeling of satellite networks;
- mobility management and service continuity;
- NTN architectures for mission-critical , emergencies, disaster response and public-safety communications
- satellite IoT and massive IoT connectivity, including energy-efficient access, distributed sensing;
- Integrated Communications And Sensing (ISAC) in the context of TN/NTN;
- system federation versus system integration in future 6G TN/NTN architectures, including interoperability, cross-domain orchestration, and trade-offs between tightly integrated and federated solutions;

- AI-driven distributed intelligence and edge computing for NTN systems, including cooperative optimization, traffic routing, traffic streering, dynamic resource allocation, and service orchestration across heterogeneous terrestrial and satellite domains;
- FR1, microwave, millimeter-wave, subTHz, optical communications, AI-enabled networking, edge/cloud integration, security and resilience;
- sustainability-by-design for integrated T-NT networks;
- ecosystemic T-NT cybersecurity techniques;
- specifically tailored simulation and emulation tools;
- satellite communications and networking supporting in-orbit computing
- academic and industrial research trends and emerging enabling technologies;
- technology maturity, gaps and barriers to adoption;
- standardization roadmaps, interoperability requirements and unresolved issues;
- activities in relevant standardization bodies and opportunities for coordinated participation;
- experimentation, validation and technology-transfer opportunities;
- Tools, emulation platforms, and proof-of-concept implementations.

AoW #2: Regulation, Industry, Market and Ecosystem

This Area of Work monitors and analyzes the regulatory, public-policy, industrial and market context in which satellite communication technologies and services evolve, with particular attention to Italy and Europe.

Key question: In which regulatory, industrial and market context are satellite communication technologies developing, and where are the main challenges and opportunities for Italy and Europe?

Main activities include:

- regulatory developments related to spectrum, authorization, security and service provision;
- national and European public policies, institutional strategies and industrial strategies;
- satellite operators, service providers, manufacturers, technology suppliers, SMEs and other ecosystem actors;
- existing and planned satellite constellations;
- market trends, emerging services and business models;
- industrial value chains, technological dependencies and ecosystem gaps;

- barriers to technology deployment and market adoption;
- market and business opportunities for RESTART partners;
- opportunities to strengthen Italian and European technological and industrial positioning.

AoW #3: Strategic Coordination and Cooperation

This Area of Work supports the translation of identified trends, gaps and opportunities into coordinated initiatives, collaborations and strategic actions.

Key question: How can technological priorities and strategic initiatives be transformed into concrete collaborations and coordinated actions?

Main activities include:

- coordination among RESTART Working Groups, projects and organizational structures;
- dialogue among academic, industrial and institutional stakeholders;
- national and European research and innovation programs;
- research, innovation, experimentation, technology-transfer and industrial cooperation opportunities;
- competences, topics and priorities to be considered for future calls, programs and strategic agendas;
- cooperation with universities, research centers, companies, operators, industry associations, standardization bodies, ministries, agencies and European institutions;
- workshops, thematic forums, round tables and invited talks;
- technical reports, white papers, position papers, roadmaps and strategic recommendations;
- liaisons with international technical panels and forums.

Across the three Areas of Work, the Working Group shall identify emerging challenges, opportunities and gaps of relevance to the RESTART community and assess them from technological, industrial, market, regulatory and strategic perspectives.

The expected impact of the Working Group is to strengthen collaboration and synergies within RESTART, improve interaction among academic, industrial and institutional communities, facilitate knowledge exchange, and support the early identification of common priorities and coordinated actions.

At national level, the Group is expected to strengthen connections within the Italian satellite communications ecosystem and support the identification of strategic needs and opportunities. At the European level, it may contribute to the wider research and innovation landscape by interacting with relevant programs, initiatives, institutions, and industrial ecosystems, and by developing shared technical and strategic orientations.

Expected Outputs, Deliverables and Milestones

The Working Group shall produce the following core outputs:

- one annual working group report, evolving towards a strategic white paper and covering major developments, findings, gaps, opportunities and recommendations;
- one contribution to the annual RESTART event;
- at least one thematic workshop per year, including expert forums, round tables or invited talks;
- identification of relevant collaborations, joint initiatives, calls and funding opportunities.

Initial milestones include:

- by 31 January 2027, preparation of a trend report for each technical Workstream, covering industrial and research developments, emerging technologies, gaps, opportunities and strategic priorities;
- within the first 6 months, the Working Group shall establish the six Workstreams and their initial priorities, complete a first mapping of relevant stakeholders, initiatives, standardization activities, programs and major technological trends, and define the first annual work plan;
- within 12 months, publication of the first Annual Report, organization of at least one thematic workshop and contribution to the annual RESTART event;
- within 24 months, preparation of at least one position paper, white paper or roadmap and promotion of relevant joint initiatives;
- towards 2030, development of a consolidated strategic outlook on satellite communications, NTN and integration with future 6G systems.

Outputs, indicators and milestones may be periodically reviewed and updated to reflect the evolution of technologies, markets, regulation, standardization and national and European strategic priorities.

Membership, Governance and Participation

The Working Group shall be chaired by Prof. Giuseppe Piro (POLIBA), with Prof. Simone Morosi (UNIFI) serving as Co-Chair.

The Chairs shall be supported by a Coordination Team comprising two representatives for each Area of Work (AoW), selected from among Working Group participants from academia and industry to ensure a balanced contribution from both communities. The Coordination Team shall assist in planning and coordinating activities, monitoring progress, facilitating exchanges among participants, and preparing the expected outputs. It shall also promote alignment across the Areas of Work and support the integration of their respective contributions into the overall objectives of the Working Group.

Participation in the Working Group is open exclusively to members of the RESTART Foundation.

A dedicated mailing list and a shared repository shall support communication among participants and the exchange of documents, materials, and outputs.

Any initiatives proposed by Working Group participants are put forward in their individual capacity and under their own responsibility. Such initiatives shall neither represent nor bind the RESTART Foundation unless expressly approved by its Board of Directors.

Coordination and Working Method

The Working Group shall operate in coordination with the relevant RESTART structures and shall actively interact with other Working Groups, projects and organizational units whenever topics of common interest, complementarity or potential overlap arise.

The Working Group shall adopt a lightweight and continuous working method based on:

- a monthly plenary teleconference to review ongoing activities, relevant developments, priorities, milestones and upcoming opportunities;
- continuous interaction among members through a dedicated mailing list and shared communication channels;
- the establishment, where appropriate, of subgroups corresponding to the three Areas of Work, with the task of following specific topics, preparing analyses and supporting the development of outputs;
- preparation of a short progress report every three months, summarizing key activities, emerging developments, opportunities, issues requiring attention and

planned actions, to be shared within RESTART and with other relevant Working Groups;

- periodic exchange of information across RESTART projects and organizations, promoting synergies and avoiding duplication of activities;
- interaction, where appropriate, with external initiatives, standardization bodies, research programs, industry associations, institutions and other relevant stakeholders.

The Working Group shall periodically review progress against its objectives, outputs and milestones and shall report its main activities, results and recommendations to the appropriate RESTART governance bodies.

The Group shall remain focused on the mandate defined by this Charter. Significant changes to its scope, objectives, Areas of Work or expected outputs shall be reflected in an updated version of the Charter.