# Glue Technologies for Space Systems
## Technical Operations Panel Report

*Cosimo Stallo*

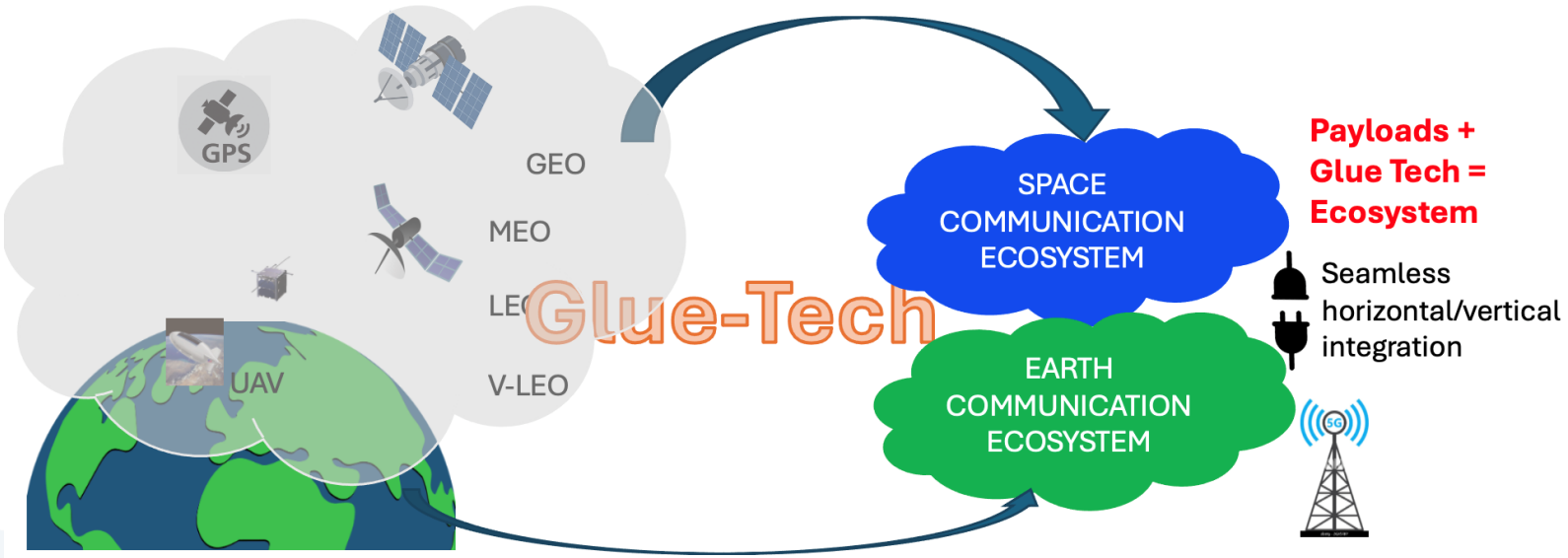
*Chair, Glue Technologies for Space Systems*

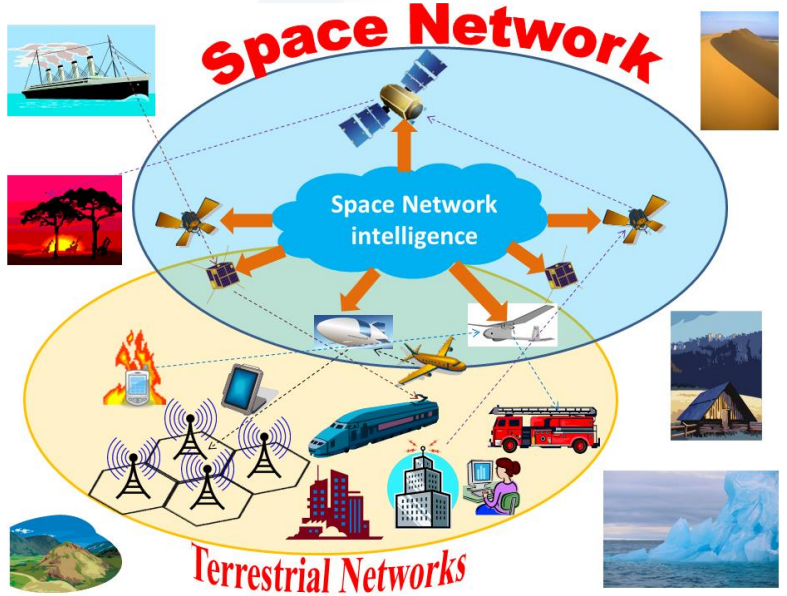
*AESS Board of Governors Meeting – Spring 2026*

*15-16 May 2026*

# “Glue-Tech” panel

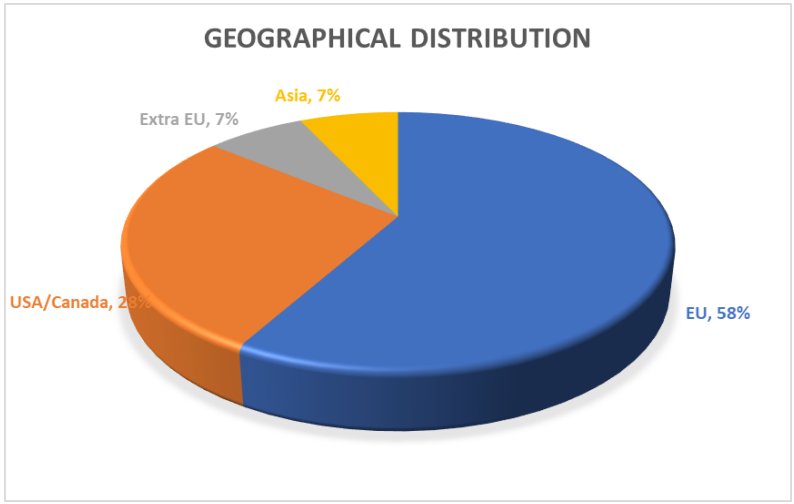
- The mission of the “Glue-Tech” panel, funded in 2019, is to strengthen the cooperation of Academy, Industry, Research Institutions and Space agencies in innovating the vision of Space technology.
- Space technology (satellite communications, aerial communications, navigation, signal processing) is regarded as the “glue” that seamlessly interconnects the ICT World in an integrated ecosystem, built around the concrete user needs. Nowadays, the “Glue-Tech” panel vision is one of the constitutive pillars of 6G.
- In the figures below, the “vision” is pictorially described. The key role in realizing the vision is played by the extensive software-defined implementation of Space network layers and by the adaptive and intelligent network management (AKA: “Space network intelligence”):

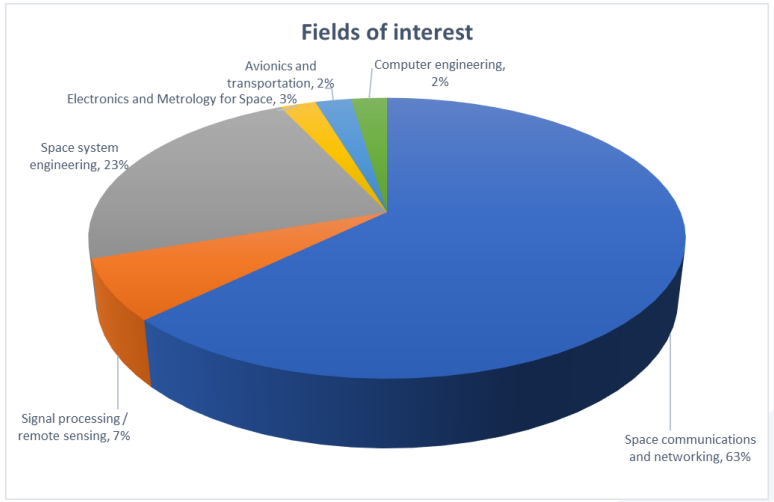


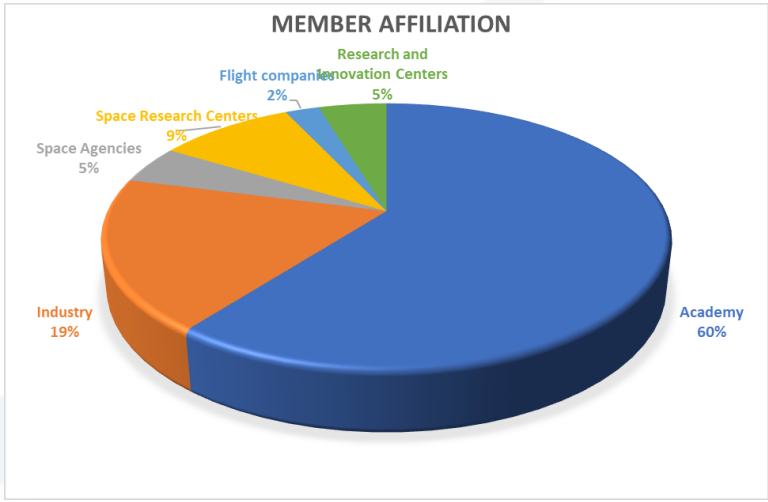



# “Glue-Tech” panel: Organization and Committees

- The “Glue-Tech” panel consists of 43 members coming worldwide from Academy, Industry, Research Centers and Space agencies. The current picture of the panel is shown in the following pie diagrams:



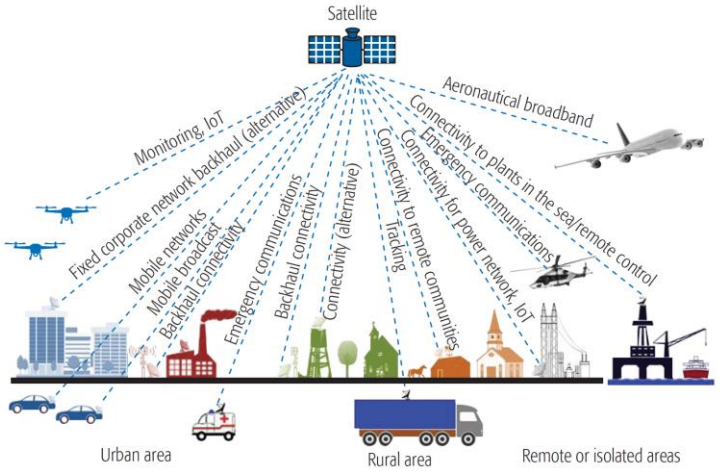



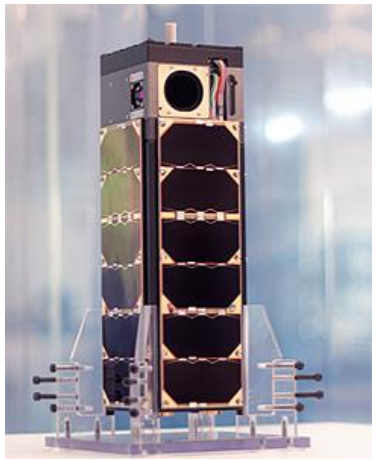

- The panel chair is Cosimo Stallo (European Space Agency), the vice-chair is Gloria Tuquerres (UPS) - Interdisciplinary Lab. for Digital Sciences), the panel secretary is Ivan Iudice (Italian Aerospace Research Centre, CIRA).

- No formal committee articulation has been established for the panel. The panelists are informally subdivided into areas of interest (communications, navigation, networking, signal processing, electronics, payload and platform engineering). Synergies are encouraged between the different areas.

# Technical areas and research fields

- The “Glue Tech” panel structure is agile and informal. However, some specific research areas of activities can be individuated:
  - Land-mobile satellite communications (LEO, CubeSats)
  - Broadband satellite communications (EHF, multi-beam satellites, megaconstellations)
  - Integrated navigation and communications
  - Aerial networks (drones, HAPS)
  - Seamless integration of satellite, aerial and terrestrial networks in the framework of 5G and 6G
  - Software-defined space network design (SDR, SDN, NFV)
  - Optical satellite links
  - Payload and platform design and implementation
  - Security and sustainability in the Space
  - Extra-terrestrial communications and networking
  - Lunar PNT and extraterrestrial navigation



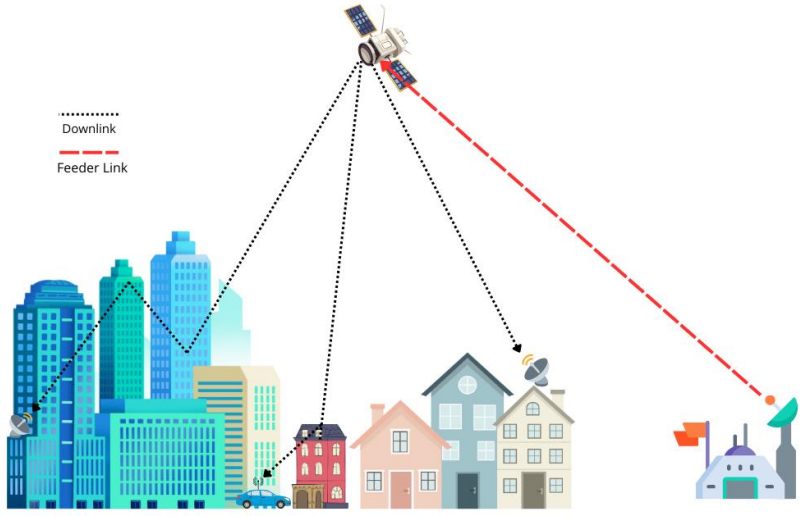



# Research and Innovation (1)

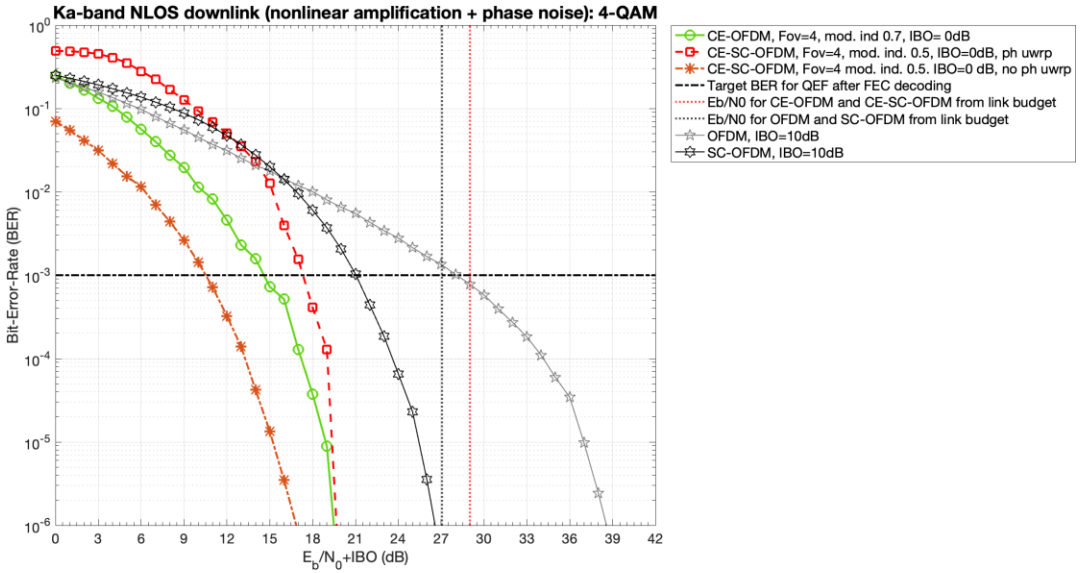
- In the year 2026, the ”Glue Tech” panel is supporting research and innovation activities in the following fields:
  - Performance assessment of novel waveforms for advanced NTN transmission scenarios.
  - Experimentation of a 5G base station mounted on a drone (former ITA-NTN PoC).
  - 6G-enabled non-terrestrial connectivity for intelligent remote manufacturing.
  - Lunar Satellite Communication and Navigation architectures and interoperable with LunaNet.

# Research and Innovation (2)

- Performance assessment of novel waveforms for advanced NTN transmission scenarios.
  - ➢ Study of **linear and pseudo-linear detection** for constant-envelope multicarrier modulations (CE-OFDM and CE-SC-OFDM) in non-terrestrial transmission scenarios (basic linear receiver and enhance receiver), as alternative to nonlinear arctangent demodulation (results are in phase of collection, an abstract will be sent at IEEE Aerospace Conference 2027):



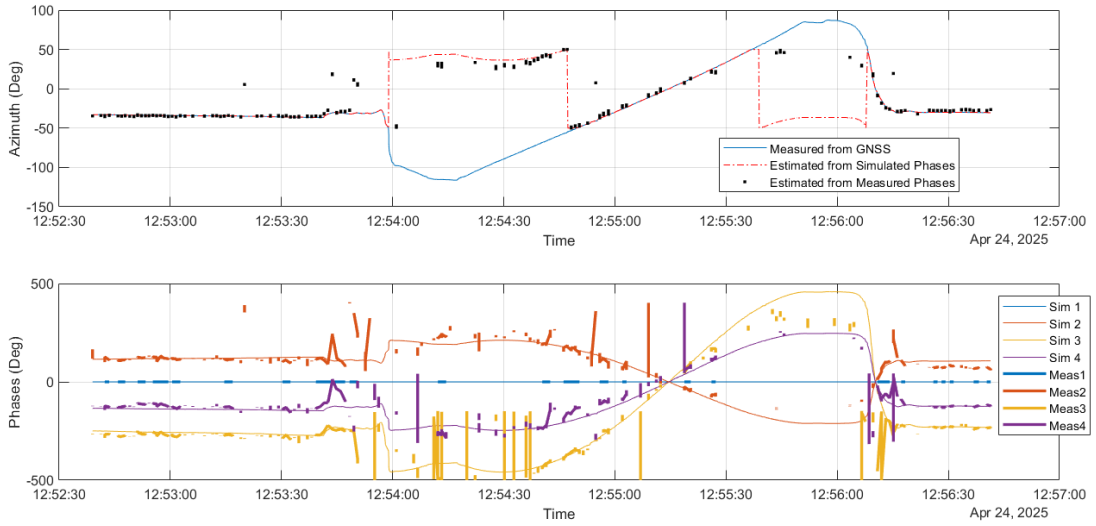

*Ka-band NTN downlink transmission scenario (LEO satellite): CE-MC are immune to nonlinear distortion*




*Results obtained with arctangent demodulator (published at IEEE Aerospace Conference 2026: they will be used for comparison)*

# Research and Innovation (3)

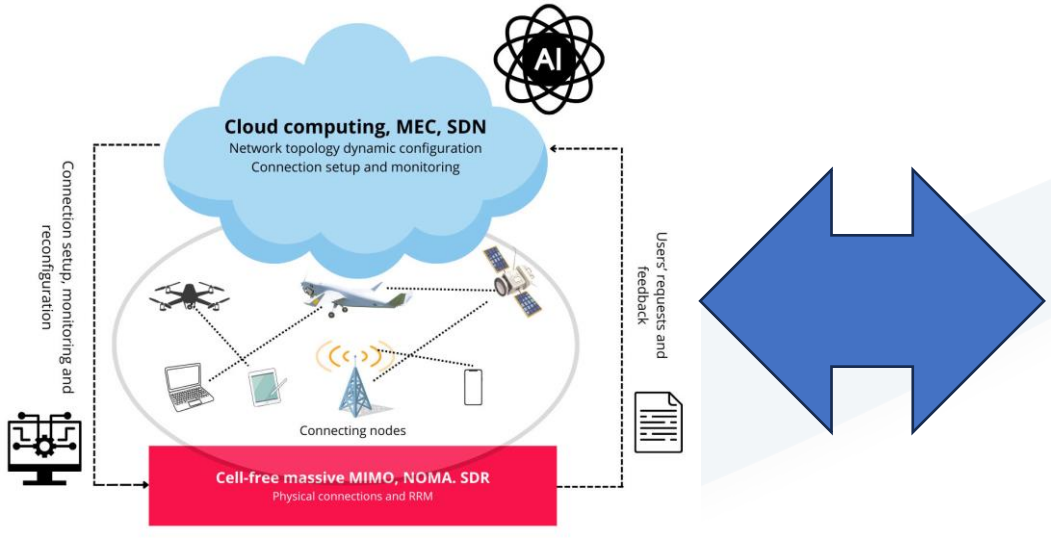
- Experimentation of a 5G base station mounted on a drone (former ITA-NTN PoC).
  - ➢ The Proof-of-Concept of the PNRR project ITA-NTN produced some results that will be published at IEEE MetroAeroSpace 2026, special track CONNECT (Madrid, July 3, 2026). The experimentation should continue after the project conclusion (hopefully, funded):




*UAV localization experiment (results about the communication experiments will be available in the MetroAeroSpace paper)*

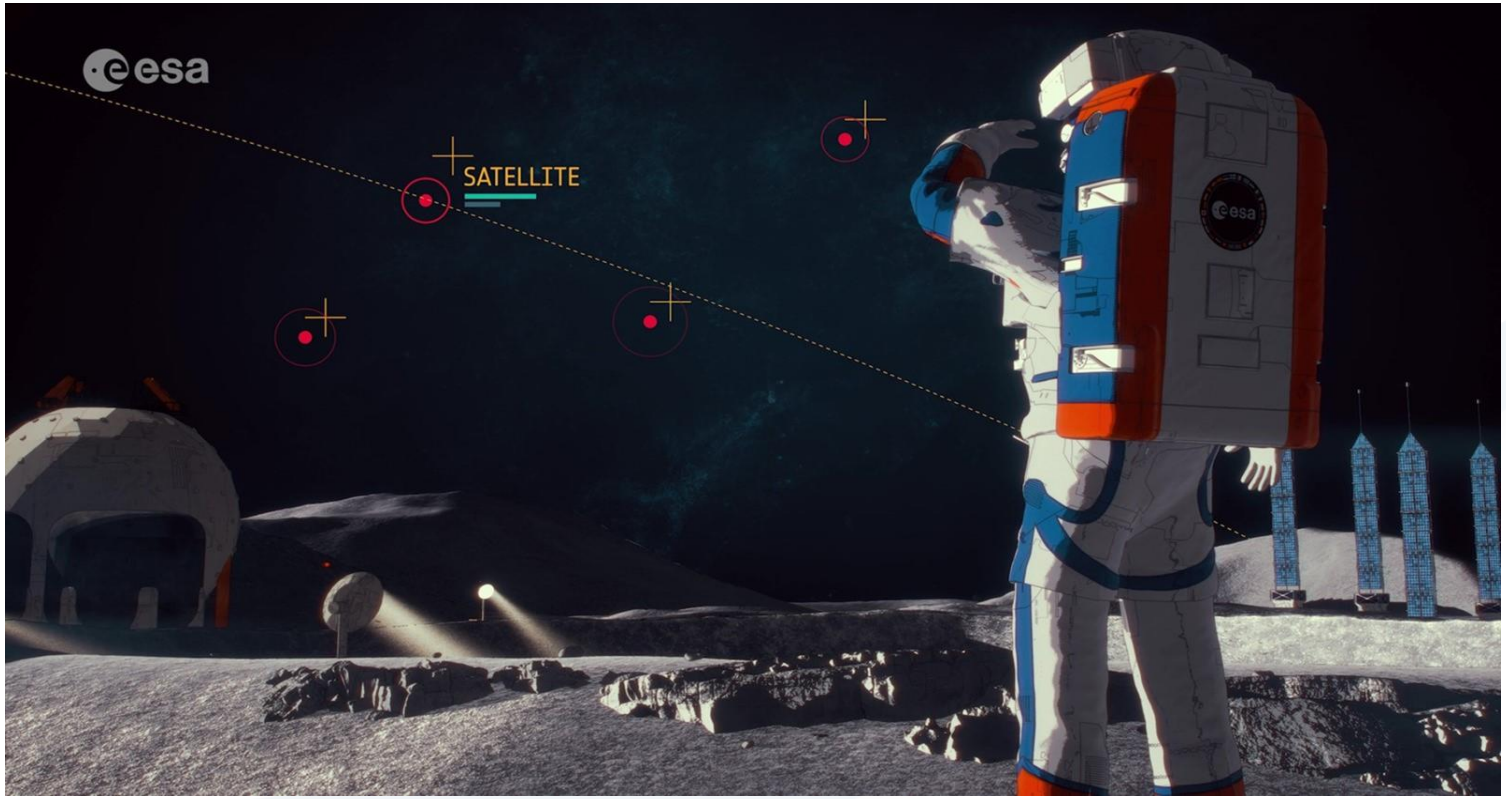
# Research and Innovation (4)

- 6G-enabled non-terrestrial connectivity for intelligent remote manufacturing.
  - Two panel institutions (UNITN and UNM) are cooperating in project activities concerning the integration of 6G-enabled NTN connectivity (drones and satellite) with intelligent remote manufacturing, performed by automated distributed factories (DREAM project)
  - A visit to UNM is planned for late August 2026 to discuss, in a workshop, the opportunity to integrate a smart 6G NTN communication ecosystem, based on software-defined implementation of network layers, intelligent C-RAN, network slicing and disaggregated NGRAN, with the smart manufacturing ecosystem.




# Research and Innovation (5)

- Design of Communication and Navigation Satellite Architectures for Moon exploration:




*Courtesy from ESA – Cosimo Stallo, Moonlight LCNS Navigation Principal System*

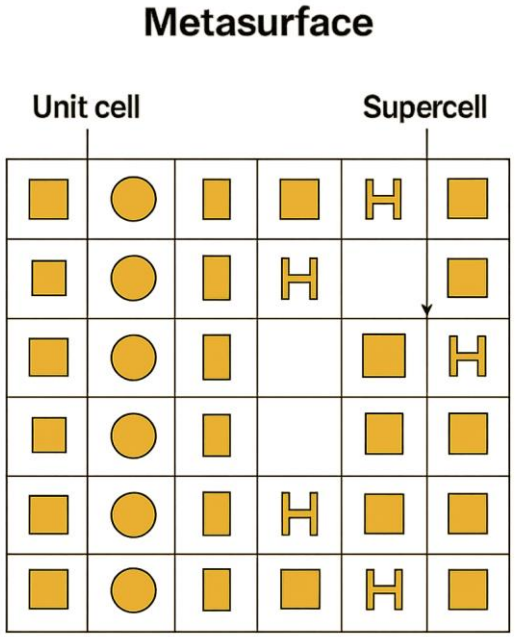
# “Glue Tech” panel – 2026 Spring Report


Cosimo Stallo

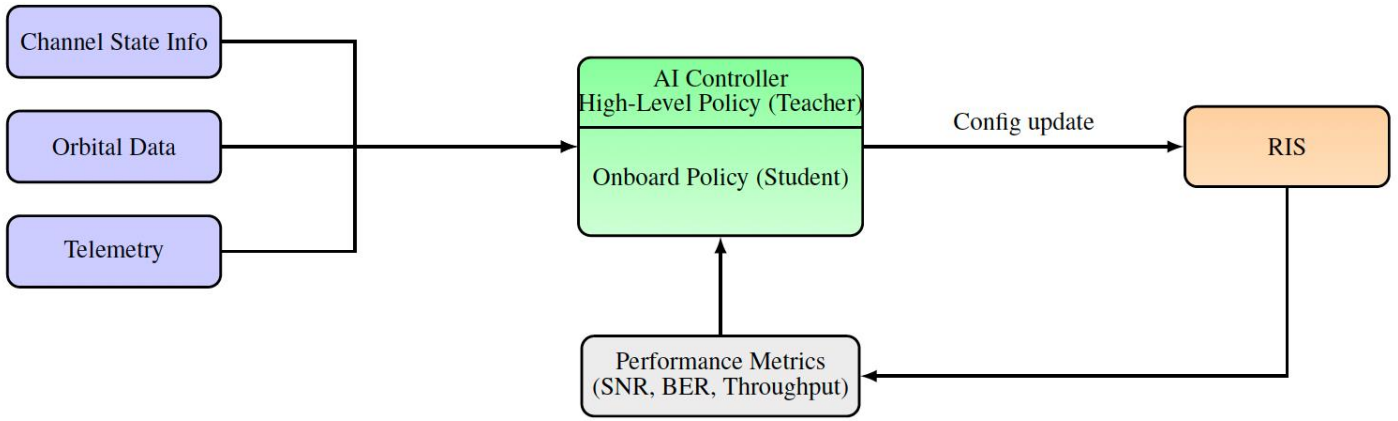
Invited talk at Munich Space Summit 2026 on Lunar PNT  focusing on LCNS  Moonlight

# Research and Innovation (6)

- Reconfigurable Intelligent Surfaces (RIS) as enabler of adaptive and modular space Communication Architectures:




*Example of RIS: Two-dimensional array of unit cells printed on a dielectric substrate.*




*AI-based RIS control loop with imitation learning Layers: the high-level policy optimizes RIS configurations based on telemetry, orbital, and channel information, while RIS performance metrics provide feedback to the onboard policy for real-time adaptation.*

*Courtesy from: I. Iudice, D. Pascarella, S. Zappia, V. Galdi, “RISs as Enablers for Adaptive and Modular Space Communication Architectures”, IEEE Aerospace Conference 2026, Big Sky (MT), 7-14 March 2026.*

# “Glue-Tech” panel: Summary of first half 2026 Activities

- First Plenary Spring Panel Meeting held on May 5th.
- Conference organization support (IEEE Aerospace Conference 2026 and 2027 IEEE MetroAeroSpace Workshop 2026, IEEE AESS Navicon 2026).
- Promote research innovation in Space technologies coping with the mission of “Glue Tech” panel.
- Organization of didactic and dissemination events concerning with the panel topics (invited talks, seminars, workshops, etc.) in the first half of 2026 and in the rest of the year.
- The “Glue Tech” panel is actively working to strengthen the organization of the yearly Summer School: *“Frontier Technologies for Space 2.0 Communications”.*
- Such an event has been successfully organized since 2021, with the participation of lecturers mostly coming from the panel. The event target is international, and the audience comes from every part of the World.
- In March 2026, the “Glue Tech” panel submitted to AESS a proposal for 4,000 USD of funding a revamped, inter-panel version of the School. The revamping considered these points:
  - Double-modality organization (in presence and in remote), choosing a location in the Space ecosystem of the Italian Lazio region (ESA site in Frascati (ESRIN) is the candidate one).
  - Organization of two inter-panel keynote speeches (in cooperation with the Avionics and Cybersecurity technical panels). Various options are under consideration.
- The proposal is in the approval cycle, and the panel will organize the School edition after its acceptance.

IEEE AESS Glue Tech Panel Summer School in September 2025 at ASI premises

# Contribution of the "Glue-Tech" to LEO SatS inter-society TC (1)

- Our panel is involved in the inter-society technical committee on LEO satellites. Various IEEE societies are also involved: AESS, MT-T, GRSS and AP-S.
- TC chair: Prof. Markus Gardill (Brandenburg University of Technology, Germany)
- The TC is planning various activities (some of them funded by IEEE), namely:

  - *Student design competitions*
  - *Virtual workshops*
  - *Conference activities*
  - *Industry forums*
  - *LEO SatS Summer School*
  - *New LEO SatS conferences*
  - *Publication and standards*

# Contribution of the “Glue-Tech” to LEO SatS inter-society TC (2)

- Some potential cooperation initiatives with the Glue Tech panel have been discussed and agreed:
  - **IEEE Aerospace Conference 2027: organization of a special session about LEO sats in the framework of Track 4.**
  - **IEEE MetroAeroSpace 2026 (Madrid, Spain, July 1-3, 2026): contributions to the special track CONNECT (an invited talk, papers, etc.)**
  - Possible contribution to the LEO SatS Summer School.

# Panel contribution to the organization of IEEE AESS events (1)

- **IEEE Aerospace Conference 2026:**
  - Session 4.03: “Next Generation Space Systems, AESS Glue”
    - *5 presented papers*
    - *3 presented papers, all them co-authored by panel members.*
  - Session 4.08: “Communications and/or Related Systems: Theory, Simulations and Signal Processing”
    - *12 presented papers, some of them co-authored by panel members*
  - Session 4.10: “Software Defined Radio and Cognitive Radio Systems and Technology”
    - *6 presented papers, some of them co-authored by panel members*


# Panel contribution to the organization of IEEE AESS events (2)

- **Special track at IEEE MetroAeroSpace 2026 workshop:**
  - *Concepts and Technologies for Next-generation Integrated Terrestrial–Non-Terrestrial Networks (CONNECT)*

**Second edition: Space communications and networking as the "glue technology" for a sustainable global** ubiquitous connectivity.

8 papers have been accepted for presentation, two technical sessions will be organized, two invited speech are planned. The best paper of the track will be awarded.

The date of the special track is JULY 3, 2026.


# Panel contribution to the organization of IEEE AESS events (3) (tentative program)

**DAY: JULY 3 - INVITED TALK #1 (SPEAKER: Ernestina Cianca, TITLE: "Space Network as a Service - Technologies for Flexible and Sustainable Space Networks") (40 min) H. 9.00-9.40**

**Session 1: Advanced technologies for satellite-based transmission, positioning, and monitoring (80 min) H. 9.40-11.00**

*A Reconfigurable Sequentially Fed Antenna Array Enabling Polarization Agility for Polarimetric SAR*

*Unlocking Fused PNT Potential in FR2 Using Multi-Beam Phased Array Antenna*

*Inter-Satellite Links for 6G NTNs: A Requirements-Driven RF/Optical Trade-off Analysis*

*Analysis of Outage Probability and Average Peak Age of Information for LEOSAT-Enabled NTFPs*

INVITED TALK GENERAL CONFERENCE (LATE MORNING AFTER COFFEE-BREAK)

**INVITED TALK #2 (SPEAKER: Chantal Cappelletti, TITLE: "CubeSat Revolution in Space and Communication") (40 min) H.14.00-14.40**

**Session 2: Unmanned Aerial Vehicles for 6G applications (80 min) 14.40-16.00**

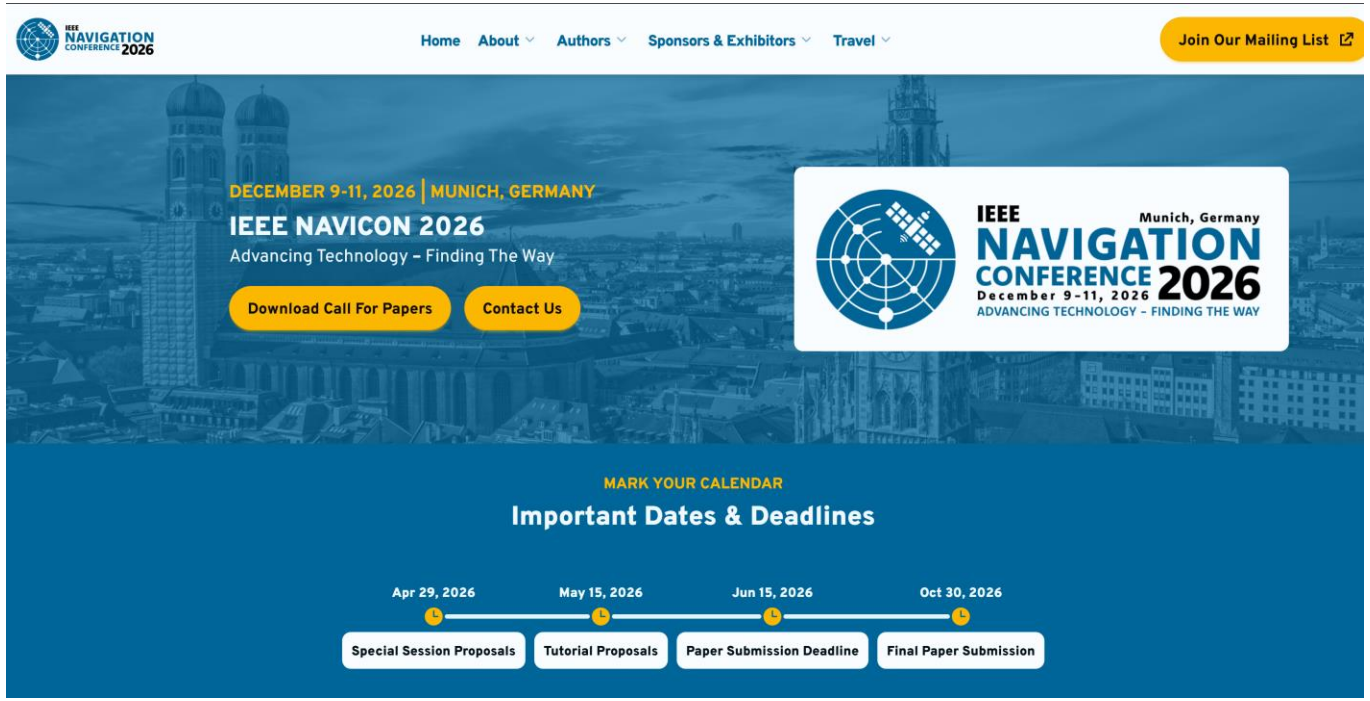
*Connectivity on-the-Fly: A Proof of Concept of Resilient Aerial Networking*

*An SNR-Based Experimental Characterization of a UAV-Mounted Metasurface for Integrated Terrestrial and Non-Terrestrial Links*

*Low-Cost UAV-Based Optical Imaging for Sea Surface Currents and Directional Wave Spectrum Retrieval*

*Edge AI Empowered UAV with Onboard Semantic Extraction for Monitoring Applications*

# Panel contribution to the organization of IEEE AESS events (4)





## Special Session at IEEE AESS NAVICON 2026 conference

*GNSS frontiers: Space, Lunar and Extraterrestrial Navigation*

**Session Chairs: Cosimo Stallo (European Space Agency (ESA)) and Masaya Murata (Japan Aerospace Exploration Agency (JAXA))**

# Participation to the AESS Grand Challenge

- Glue-Tech panel has been involved in the inter-panel grand challenge:
  - *Cyber-Security of AI and AI for Cyber-Security*
- The proposal was accepted and the Grand Challenge has been funded.
- The contribution of Glue Tech panel was focused on the security threats (and related solutions) concerning satellite firmware updates and PHY-layer integrity.

# Acknowledged publications

- C. Sacchi et al., "An Ecosystemic Approach for the Seamless Integration of Terrestrial and Non-Terrestrial Network Connections," **in IEEE Open Journal of the Communications Society**, vol. 7, pp. 2344-2384, March 2026, doi: 10.1109/OJCOMS.2026.3670414.

- C. Sacchi, G.M. Mendolia, G. Buttazzoni «An NTN Uplink Radio Interface Based on Constant-Envelope Multicarrier Modulations and NOMA», **IEEE Aerospace Conference 2026**.

- C. Sacchi, A. Tarable, G. Virone, S. Morosi, «CE-Multicarrier Modulations vs. Multicarrier Modulations in Non-Terrestrial Network Scenarios», **IEEE Aerospace Conference 2026**.

- I. Iudice, G. Gelli, D. Darsena, «AI-Driven Design of Stacked Intelligent Metasurfaces for Software-Defined Radio Applications», **IEEE Aerospace Conference 2026.**

- I. Iudice, D. Pascarella, S. Zappia, V. Galdi, «RISs as Enablers for Adaptive and Modular Space Communication Architectures», **IEEE Aerospace Conference 2026.**

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# Educational Activities

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  - Organization of two inter-panel keynote speeches (in cooperation with the Avionics and Cybersecurity technical panels). Various options are under consideration.
- The proposal is under acceptance cycle approval.

# “Glue Tech” Summer School 2025

- **FACTS AND NUMBERS:**
  - **LOCATION:** Italian Space Agency (ASI), Rome, Italy
  - **32 hours of lectures**, distributed in 5 days.
  - **Two inter-panel invited lecturers**: **Zak Kassas** (chair of Navigation Systems Panel) and **Giancarmine Fasano** (chair of the Avionics Systems Panel)
  - **Three special invited lecturers: Simone Morosi** (vice PI of ITA-NTN RESTART project), Lt. Col. **Claudio Gizzi** and **Gen. Claudio Gabellini** of Italian Air Force.
  - **117 registered students**, coming from every part of the World (not only PhD students, but also Master Students, Industrial and Academic researchers, curious guys, etc.)
  - **40 students** attending in remote every lectures.
  - **16 students** attending in presence in the ASI room.
  - **21 exams passed**.

# Educational activities: distinguished lectures

- **Topic: space sustainabilty: to be reproposed for second half of the year 2026**

**Design Guidelines for Space Sustainability by Marina Ruggieri**
**Date & Time**
**Webinar ID**
**Description**
The interest and sensitivity to the sustainability of the space environment is growing, along with respect for international guidelines to reduce debris. Nonetheless, the level of space sustainability remains unsatisfactory, particularly in the long term. This is not an ideal scenario for the key role that large satellite constellations are playing and will continue to play in providing global connectivity and achieving the “connecting the unconnected” goal.
Technology, particularly artificial intelligence and the software-defined paradigm, as well as bold design choices and extensive coordination among space players, are crucial allies in making global connectivity and space sustainability feasible without compromising one for the other. Increased awareness is needed regarding technologies and design approaches that are intrinsically sustainability-prone.
The Distinguished Lecture (DL) is aimed at providing ideas and potential solutions to achieve the goal of connectivity in a sustainable space environment. This can be made feasible in the medium and long term through a profound change in the design approach.

# Industry Engagement and Standards

- The “Glue Tech” panel provided a contribution to the standardization of 6G Non-Terrestrial Networks in the framework of the synergy with the *NextGenerationEU* workprogramme.
- The panel is involved in some structural projects of the programme funded at Italian level (*RESTART* workprogramme).
- The actions, carried out in the framework of the RESTART structural project ITA-NTN (*Integrated Terrestrial/Non Terrestrial Network*), can be listed as follows:
  - Establishing a liaison between ITA-NTN and ETSI, started with the participation to the 2024 ETSI Conference on “Non-Terrestrial Networks: A Native Component of 6G”, and currently on-going.
  - Open access publication of the following paper, planned in September 2025 (manuscript accepted, in press):
    - A. Rago, A. Guidotti et. al., “Innovative Multi-Layer Approaches for 6G Integrated Terrestrial And Non-Terrestrial Networks”, **IEEE Communications Standards Magazine**, special issue: Integrated Terrestrial and Non-Terrestrial Networks.

# “Glue Tech” panel – Ongoing Plans for 2026

- Future plans of “Glue Tech” panel should consider:

  - To foster existing didactic initiatives (already done with the Summer School) and planning new initiatives targeted to Master and undergraduate students (e.g.: seminars, thesis awards, short courses, etc.)
  - To increase the involvement of companies in the panel, planning for instance, ad-hoc presentation of the panel activities to be shown to industries.
  - To strengthen the liaisons of the “Glue Tech” panel with other technical panels (some initiatives have been already put on the board.)
  - To produce top-class publications dealing with a global vision of “Glue technology” with the eye open to a more and more interconnected future World.
  - To promote a responsible and sustainable vision of the integrated terrestrial-non terrestrial connectivity as a mean to build bridges connecting people, rather than walls separating them.