



ETSI Conference on
Non-Terrestrial Networks,
A Native Component of 6G

Fully Integrated Terrestrial / Non-Terrestrial Networks for 6G Communications The ITA NTN Project

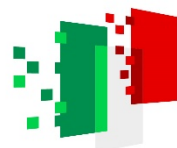
Prof. Simone Morosi



04/04/2024



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Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



RESTART Program

A program including research projects to be jointly carried out by universities, research centres, companies, and PAs, with transversal and supporting actions and adequate tools and enablers

- Proponent: University of Rome Tor Vergata
- Management Legal entity: RESTART Foundation (www.fondazione-restart.it)
- 25 Partners
- Grant: 116 M€
- Duration: January 1, 2023 – December 31, 2025

Vision:

A 3D network architecture, able to exploit connections established (and dynamically configured) among ground and space/aerial network elements to provide heterogeneous services and applications



Università di Roma, Tor Vergata
Consiglio Nazionale delle Ricerche
Politecnico di Bari
Politecnico di Milano
Politecnico di Torino
Scuola Superiore Sant'Anna di Pisa
Università di Bologna
Università di Catania
Università di Firenze
Università di Napoli Federico II
Università di Padova
Università di Reggio Calabria
Università di Roma Sapienza

CNIT
Fondazione Ugo Bordonini
Open Fiber
TIM
Vodafone
Wind Tre
Ericsson
Prismian
ITALTEL
LEONARDO
Athonet
TIESSE

ITA NTN Project: expected results and envisaged impacts

- Design a **3D multi-layered communication architecture** for integrated T/NT networks
- Evaluate the **link budget** (Focus on free-space, optical, and radiofrequency communication links)
- Design of **advanced transmission techniques**
- Conceive innovative methodologies for the **orchestration of communication and computational resources**
- Evaluate the **performance** of conceived approach (Proof of Concepts)

- Contribute to the ongoing **definition of the 6G**
- Define **digital, secure and sustainable** techniques
- Reduce the **Digital Divide** (connectivity as a fundamental right)
- Improve knowledge through **dissemination**

ITA NTN
Integrated Terrestrial and
Non-Terrestrial Networks
PI: Prof. Luigi Alfredo Grieco
Politecnico di Bari



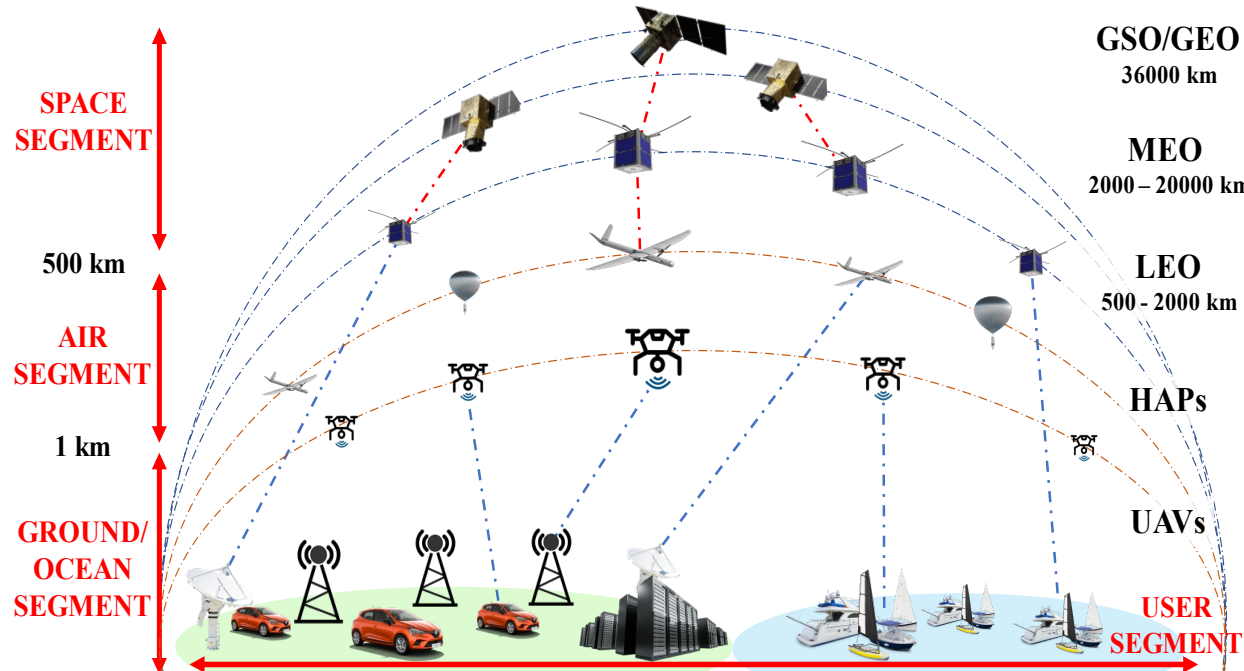
From 5G to Integrated Terrestrial / Non-Terrestrial Networks

5G Pillars

enhanced Mobile Broadband
(eMBB)

Ultra-Reliable Low Latency
Communications (URLLC)

Massive Machine Type
Communications (mMTC)



Non-Terrestrial Networks

SATELLITE

- spaceborne systems (Geostationary Earth Orbit, GEO),
- Medium Earth Orbit (MEO), Low Earth Orbit (LEO)
- non-geosynchronous (non-GSO) orbiting satellites
- airborne systems, i.e., High-Altitude Platforms Stations (HAPS)
- Unmanned Aircraft Systems (UAS) or Unmanned Aircraft Vehicle (UAV), i.e. without driver (i.e. drone)

The Use Cases of interest for the ITA-NTN project



Functional KPIs that are deemed relevant for ITA NTN communications

End-to-end latency	Reliability	User experienced data rate	LEO/GEO link	Ground-HAP link	HAP-sat link	Satellite feeder link	ISLs
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Contributions to 6G – NTN Standardization Process

FSO Adoption in
inter-satellite links and
in Space segment

**NR Waveforms and
advanced
multicarrier
configurations** for
fast Doppler channels

Adoption of **Cell-free
massive MIMO**
framework in
integrated T/NT
networks

**Antenna arrays and
multibeam strategies**
for high throughput
communications

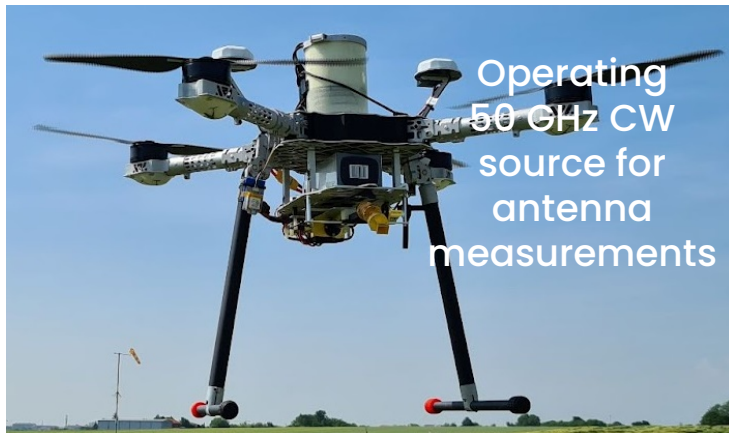
Design **ML/AI-based
edge computing**
solutions for T/NT
scenarios with drones
involved

Definition of
**communication
protocols** for the
integrated TN-NTN
infrastructure

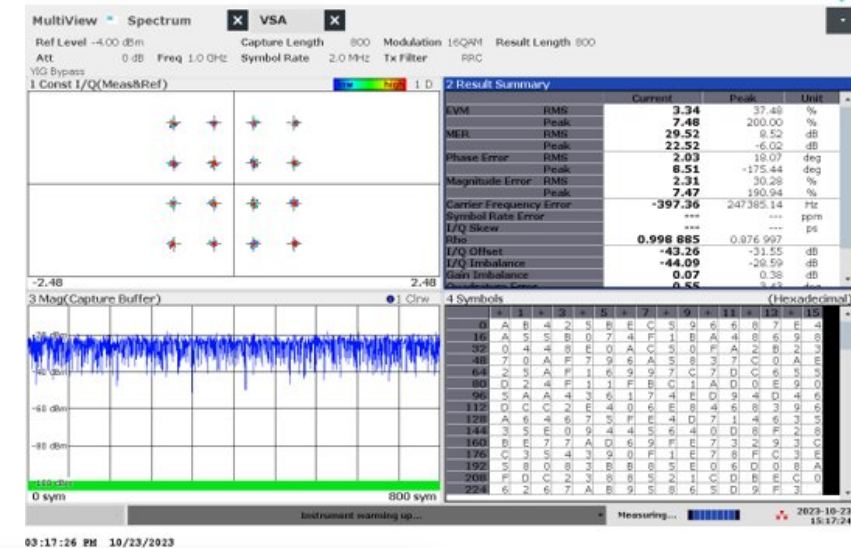
Proof of Concepts (PoCs)

Vector Signal Generator on UAV (SDR-based)

Channel sounding measurements for UAV-ground links

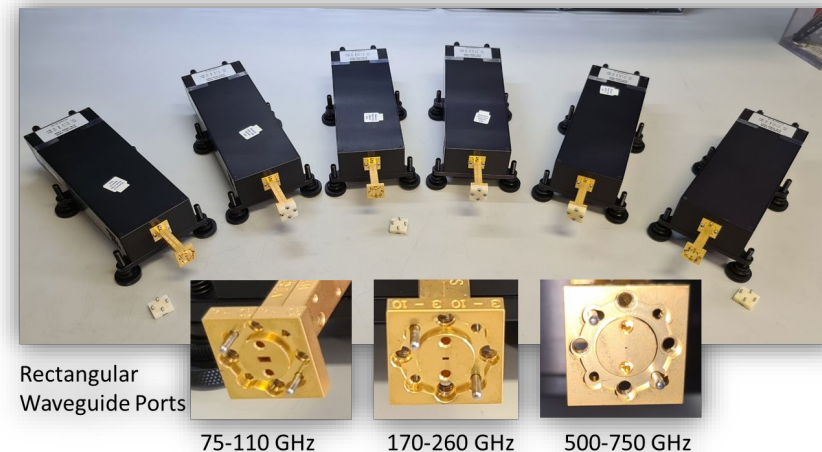


Spectrum and Vector Signal Analyzer operating up to 67 GHz with 2 GHz of analysis bandwidth, up- and down- conversion extenders in the frequency bands 60-90 GHz and 110-170 GHz



Vector Network Analyzer System

- Material Testing (graphene, silicon,...)
- Device Testing (micromanufactured devices, graphene-based antennas)
- Channel Measurements



CNR - IEIT
In collaboration
with RESTART
Project ARCADIA

PoCs to be developed in the Restart laboratory at Politecnico di Bari (I)



The Experimental laboratory of integrated Terrestrial and Non-Terrestrial Networks and Services (**iTNT-NS**) at Politecnico di Bari provides state-of-the-art equipment to support the activities of the RESTART program which include:

- study of the coexistence between T/NT communications
- performance analysis of 3D ML communication architecture
- measurements and performance analysis of transmission and network orchestration techniques and services
- definition of architecture, components, APIs and tools to build and validate advanced test platforms for 5G and 6G

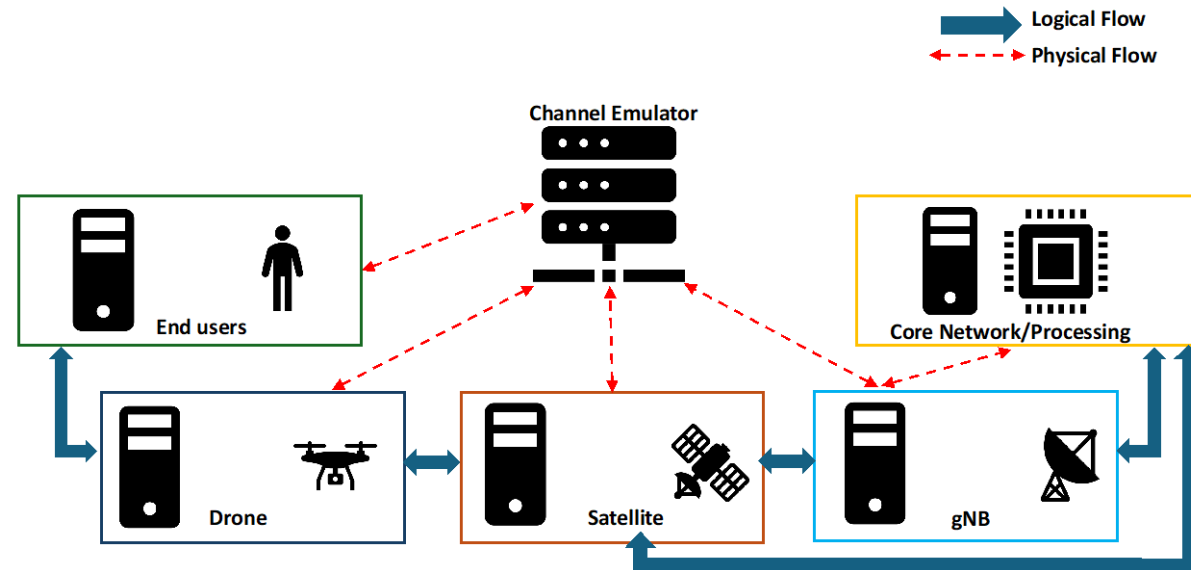
Location of iTNT-NS lab: Politecnico di Bari, Bari, Apulia - Italy

Head of iTNT-NS lab: Prof. Luigi Alfredo Grieco

Responsible of iTNT-NS lab: Prof. Giuseppe Piro

Emulation of integrated T/NT networks

Implementation of a 3D network prototype integrating terrestrial and non terrestrial nodes



PoCs to be developed in the Restart laboratory at Politecnico di Bari (II)

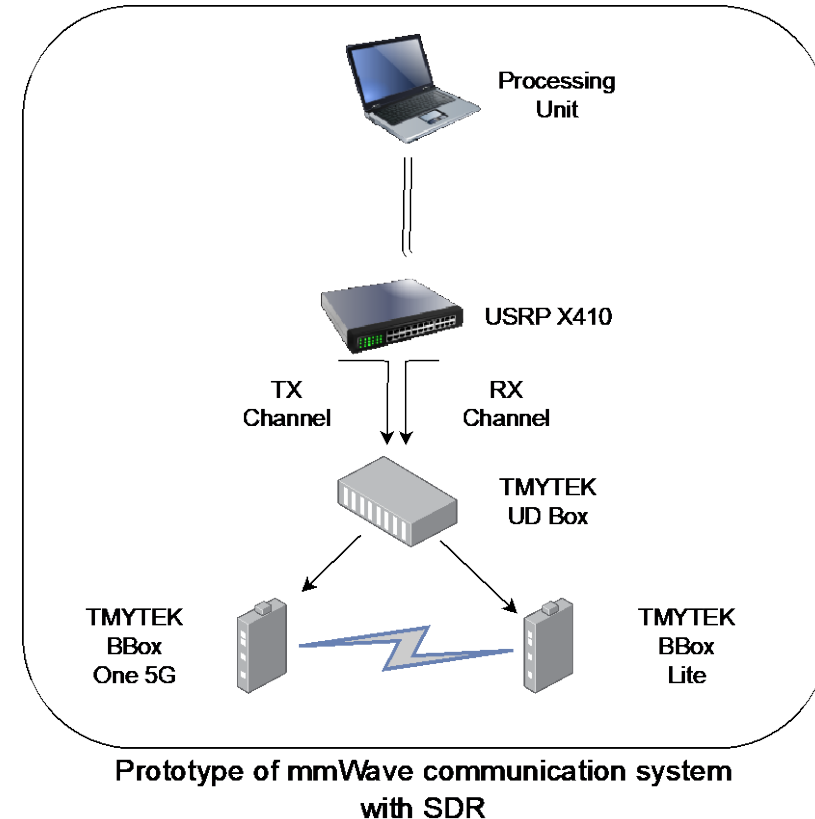
5G-enabled Internet of Drones (IoD) scenarios

5G network bubble providing radio connectivity to heterogeneous UAV users



Advanced services offered by 5G and B5G

mmWave prototype for communication and sensing



Conclusions

- The **aim** of **ITA NTN** (RESTART Structural Project) is to **design** and **analyze a 3D multi-layered network infrastructure** to achieve seamless connectivity, network resilience, reliable communications, and enhanced throughput for many vertical sectors
- The project time plan and contents are **fully aligned and consistent** with the **global Beyond 5G** (5G-Advanced and 6G) **standardization and development** roadmap
- Non-Terrestrial Networks will be fundamental in some sectors (e.g., AUTOMOTIVE, ..)
- Integration with Terrestrial in 6G Standardization
- Objectives: Define suitable 3D architectures
- Management based on SDN/NFV with AI; Spectrum sharing

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