Signal Processing and Communications (SIGCOM) Group

Dr. Konstantinos Ntontin
Research Scientist
Interdisciplinary Centre for Security, Reliability and Trust
UNIVERSITY OF LUXEMBOURG

SIGCOM in Numbers

- Created in 2009
- Total estimated **budget** 2024 ~ ca 11MEuros

Head: Prof. Symeon Chatzinotas

Personnel: ~100

- 2 Prof. (2 IEEE Fellows)
- 10 Research Scientists
- ~ 30 Postdocs
- ~ 30 Doctoral students
- 14 Research Fellows
- 3 Research Specialists
- 3 Support & Technical Personnel
- 6 MSc students

https://www.uni.lu/snt-en/research-groups/sigcom/

Main Areas of Expertise:

- Wireless Comms & Networking
- Non-Terrestrial Networks
- Quantum Communications

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6G Research Areas

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6G Research Areas

Non-Terrestrial Networks (NTN)

- Efficient phase arrays, digital BF techniques
- Broadband in rural regions
- Emergency communication systems for disaster scenarios
- Earth – Lunar, Earth - Mars comms.
- Highly secure comms

ANTENNAS AND DIGITAL BEAMFORMING | **NTN FOR REMOTE AND UNDERSERVED AREAS** | **NEXT-GENERATION SATELLITE PAYLOADS**

Short-Term | Mid-Term | Long-Term

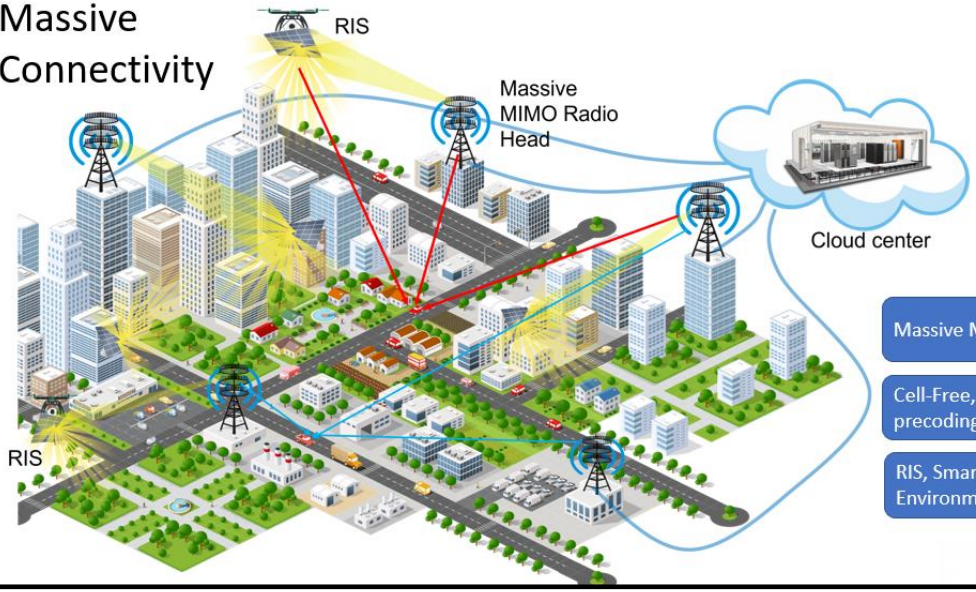
SEAMLESS INTEROPERABILITY | **SPECTRUM MANAGEMENT AND COEXISTENCE** | **DISTRIBUTED SATELLITE SYSTEMS**

- Protocol development for TN/NTN,
- Handover mechanisms between ground networks and satellites

- Spectrum-sharing strategies
- Coexistence and interference management

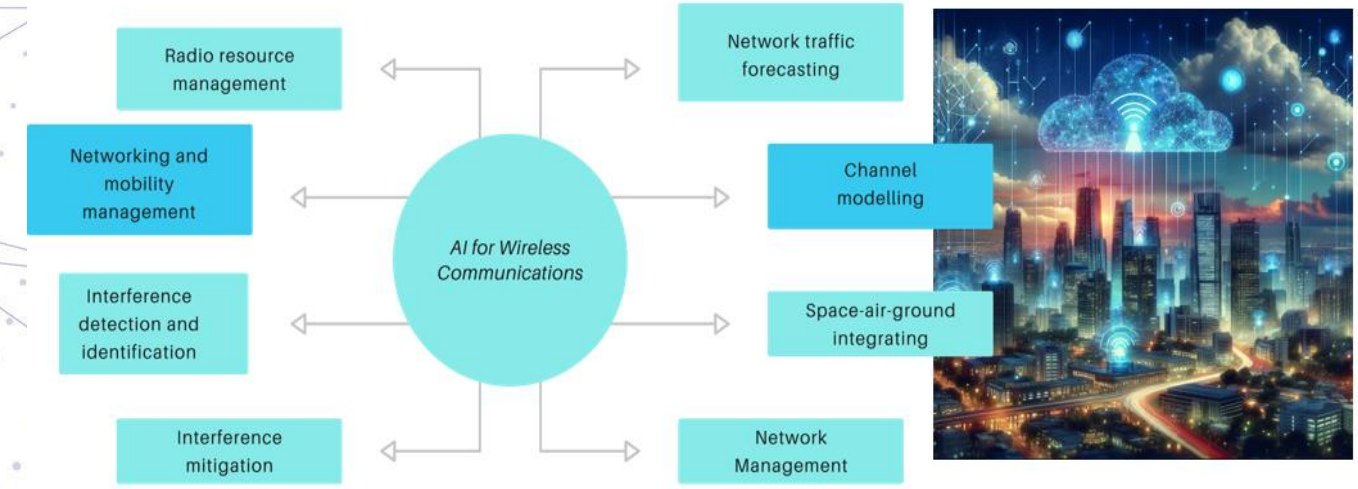
- Self-organized satellite swarms
- Coherent comms. for future satellite constellations

Massive Connectivity



- Massive MIMO
- Cell-Free, distributed precoding
- RIS, Smart Radio Environment

AI/Machine Learning in 6G



Quantum Communications

- Quantum Key Distribution Networks
- Non-Terrestrial to Terrestrial Quantum Links
- Time-Varying Quantum Channels
- Integration of 6G-Mobile & Quantum Communication
- Quantum Computing for B5G Networks

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EC Projects

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European Commission Projects

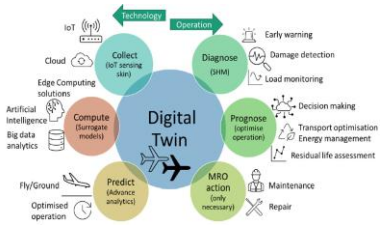
Unified Terrestrial/Non-Terrestrial Networks

ETHER

Project Coordinator,
SNS JU Call 1

TRANTOR

Quantum Communication Infrastructure for Security



AVATAR

Lux4QCI

Project Coordinator

Healthcare 4.0

XTRUST-6G

SNS JU Call 3

ELIXIRION

AI-enabled IoT 5.0

TALON

Multiple-Antenna Communication/Reconfigurable Intelligent Surfaces

TERRAMETA

SNS JU Call 1

Optical Communications

AVALON

Distributed Ledgers

SOVEREIGN

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Main Expertise and Interest in SNS JU 2025/Experimental Infrastructure Provision
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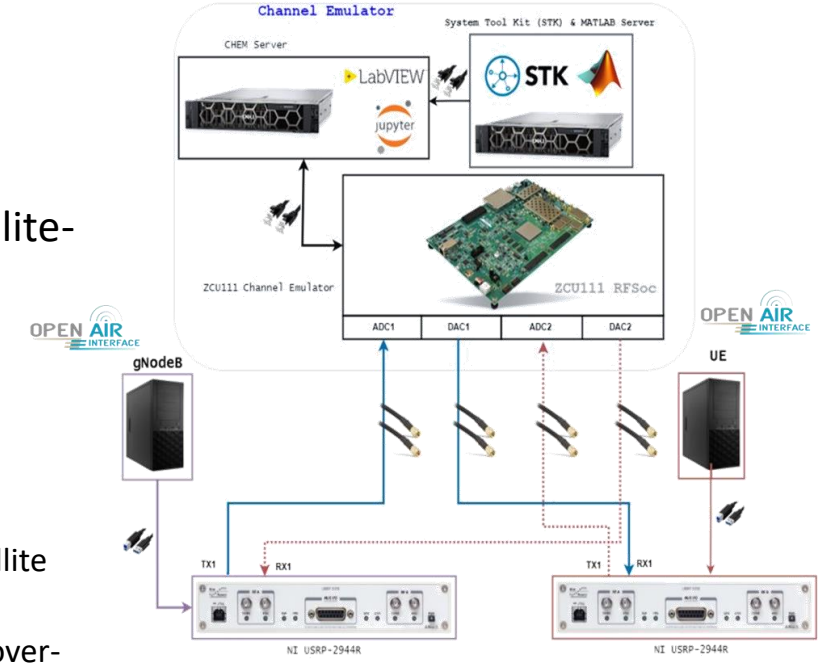
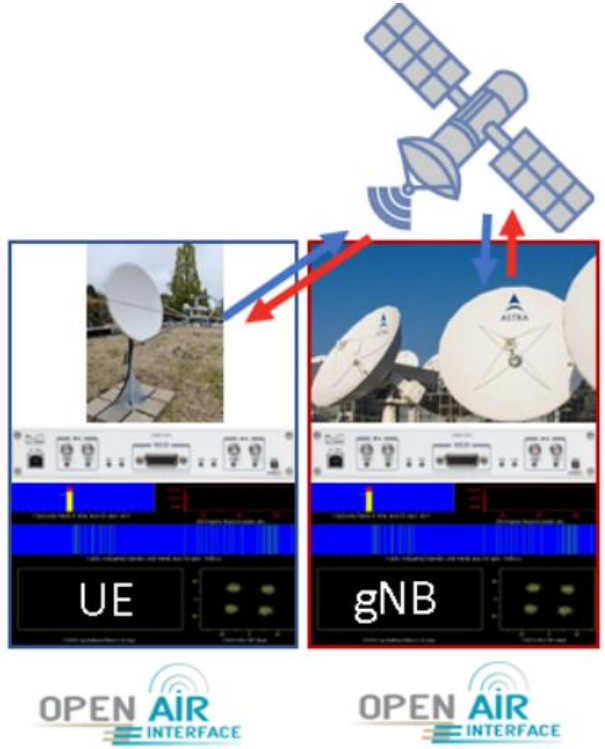
HORIZON-JU-SNS-2025-STREAM-B-03-01: 6G NTN-TN Unification/Integration

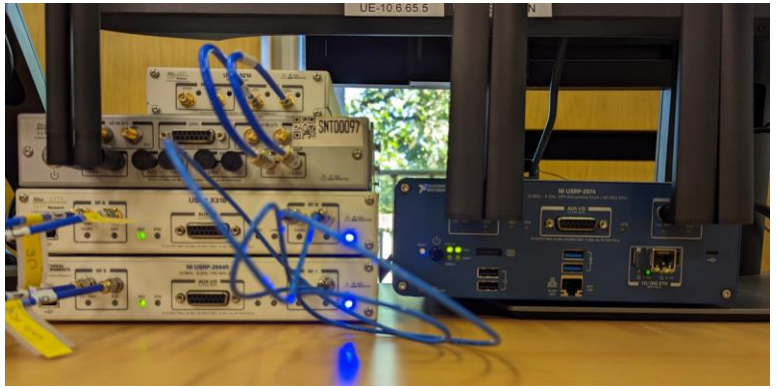
- **From the call description, we offer expertise in *management and orchestration, dynamic routing, optimisation at a system and subsystem level, spectrum issues***

6GSPACE Lab

- 6GSPACE Lab (15+ people)
- Facility for design and testing of 5G/6G Satellite-NTN-Space
- Multiple 5G/6G NTN research testbeds:
  - 6G NTN Multiorbit Emulation
  - 6G NTN Over-The-Satellite
  - 6G NTN AI-acceleration
  - 6G NTN Spectrum Sensing (Ku/Ka antennas for satellite tracking)
  - Joint Communications and PNT (5G-NTN/LEO PNT, over-the-air)
  - Joint Communications and Sensing (emulation)
- Active in supporting 3GPP standardization (participation in the NTN forum, we support SES):
  - **3GPP Release 19**: SDR-based Regenerative Payloads, Multicast and Broadcast Service from 5G NTN, Uplink enhancements
  - **3GPP Release 20** topic proposals: GNSS-free Operation and accurate PNT, Joint Comms and Sensing, Dynamic spectrum Allocation, Multi-orbit Multi-connectivity



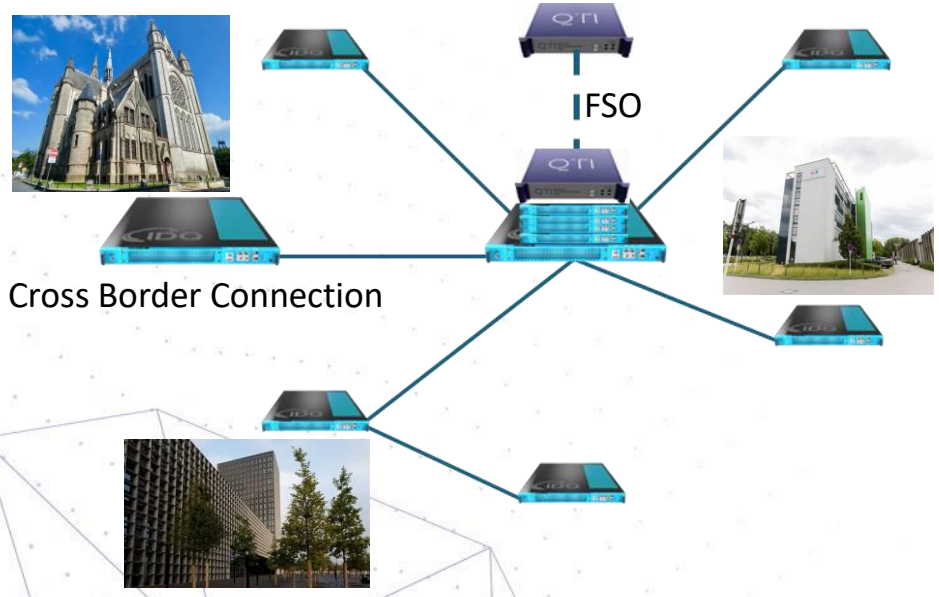


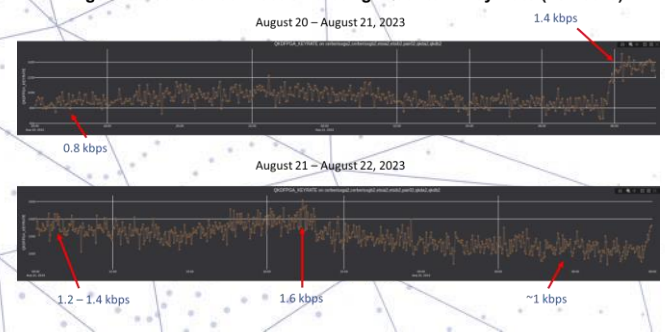


HORIZON-JU-SNS-2025-STREAM-B-03-02: Higher Speed Optical Access Networks and future end-to-end Packet Optical Network Architecture in 6G

- **From the call description, we offer expertise in *Quantum networking over fiber for trustworthy systems and applications***

Quantum Infrastructure





Testbed Overview:

- A **Cross-Border** Connection
- **Star** (hub-and-spokes) **topology**
- **Different Technologies**
  - **Prepare-and-Measure QKD**
  - **Measurement Device independent QKD**
- Different geographical sites. Dark/lit fiber links connecting several sites
- An **FSO** link
- An in-home built **SDN-based KMS** (Compliant with ETSI 014 standards)
- EAGLE-1 Emulator for satellite QKD

Achievements:

- First **long-distance** QKD demonstration in Luxembourg
- Demonstration of a terrestrial cross-border QKD connection
- QKD demonstration over an **operative fiber**

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Further Expertise and Interest in SNS JU 2025

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SNS-2025-STREAM-B-01-01: Advanced Architectures Systems and Technologies

- Algorithmic expertise in ***AI-Based Goal-Oriented Communications [1]-[3]***

SNS-2025-STREAM-B-02: Wireless Communication Technologies and Signal Processing – Standardisation and Follow-up/PoCs

- Algorithmic expertise in:
  - ❑ ***Physical-Layer Security [4]-[6]***
  - ❑ ***Massive MIMO [7]-[9]***
  - ❑ ***Embedded & Neuromorphic AI/ML [10]-[12]***
  - ❑ ***Semantic Communications [13]-[15]***
  - ❑ ***Dynamic Spectrum Sharing [16]-[18]***
  - ❑ ***O-RAN, RAN Disaggregation [19]-[21]***

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