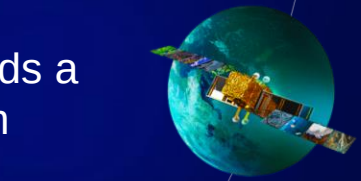
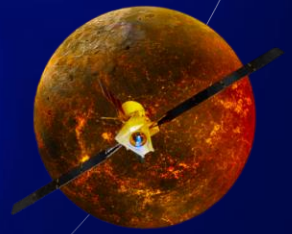
ThalesAlenia Space
a Thales / Leonardo company

5th NTN Workshop: Towards a unified TN-NTN system

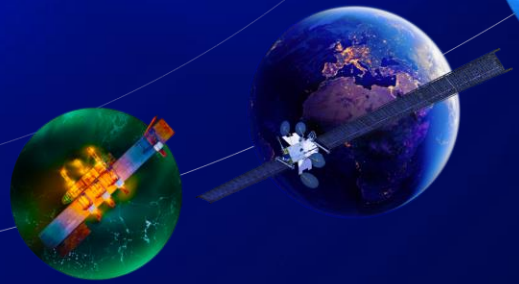
November 6, 2025





5G NTN IMPLEMENTATION: INTEGRATED SPACE NETWORK SYSTEMS FOR THE CONNECTIVITY OF THE FUTURE

Speaker: V. Schena



ThalesAlenia Space
a Thales / Leonardo company

JOINT VENTURE

ThalesAlenia Space
a Thales / Leonardo company

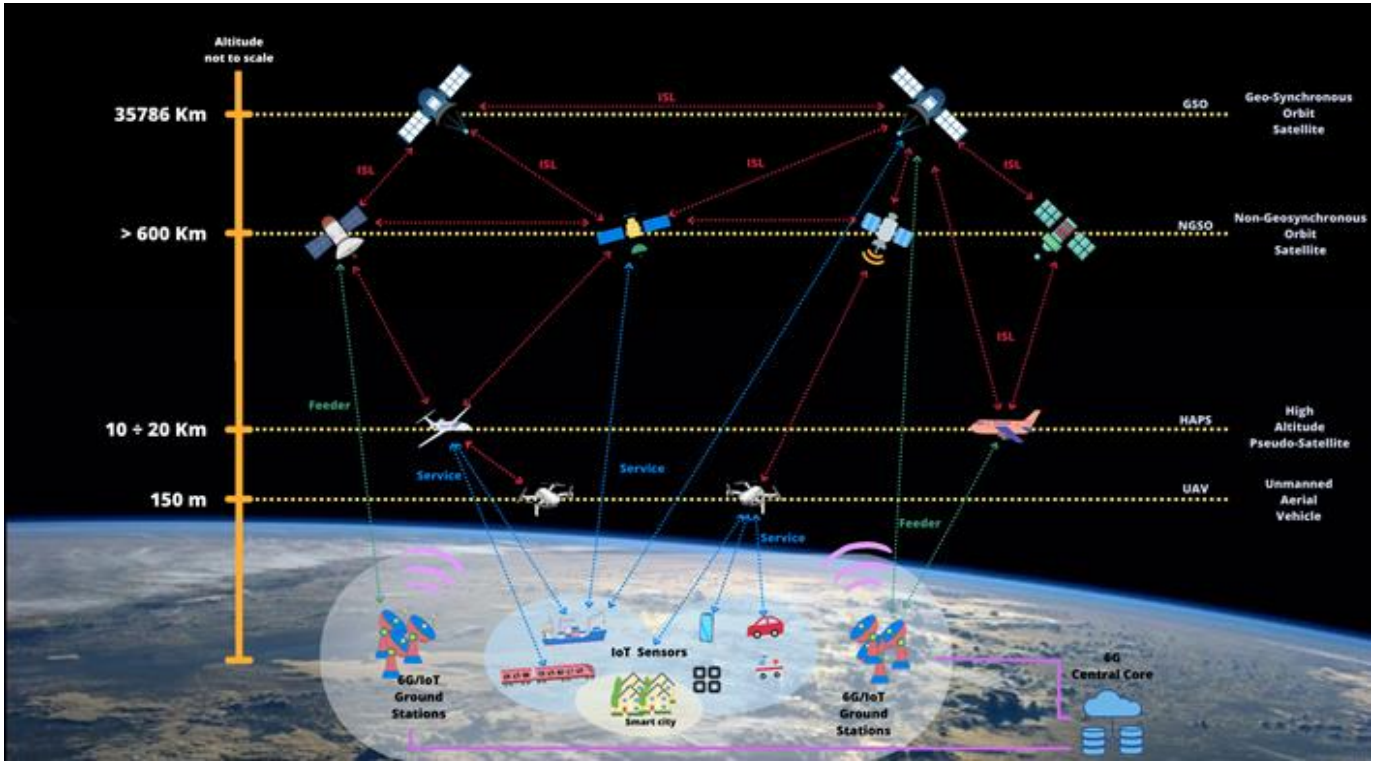
THALES (67%)
LEONARDO (33%)

/// The technologies for the future space communications:

- Digital on-board Processing Systems
- Smart Active Antennas for Small Platforms
- Optical/Photonic Space Technologies
- 5G/6G NTN Technologies and Services
- Space Networking Systems (SpaNeS)
- Cyber-security and Post Quantum Cryptography (PQC)
- Quantum Communication Infrastructures (QCI)

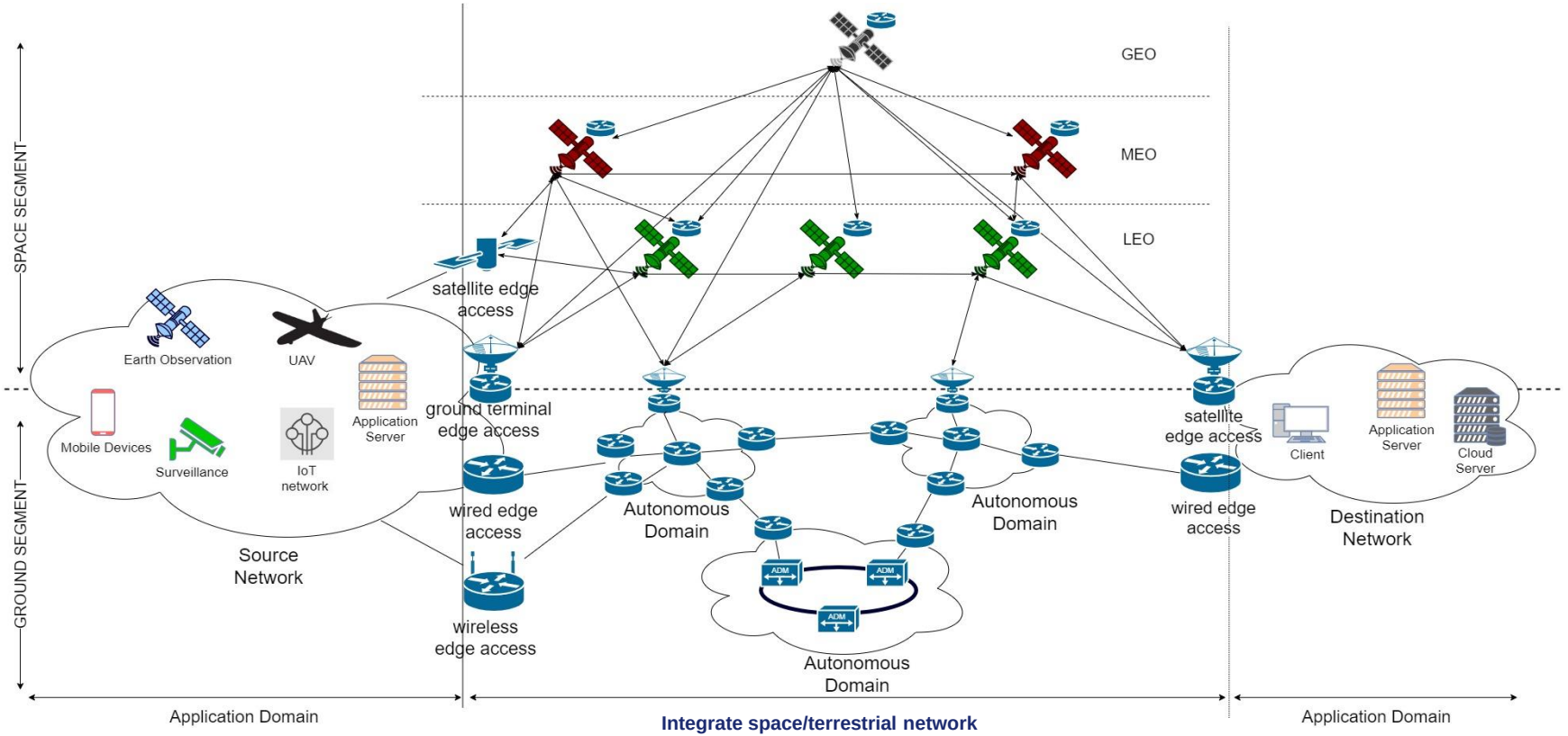
Date: 5/02/2026
Ref: O-RAN Alliance Workshop
Template: 83230347-DOC-TAS-EN-011

INTEGRATED SPACE-EARTH NETWORK: THE VISION



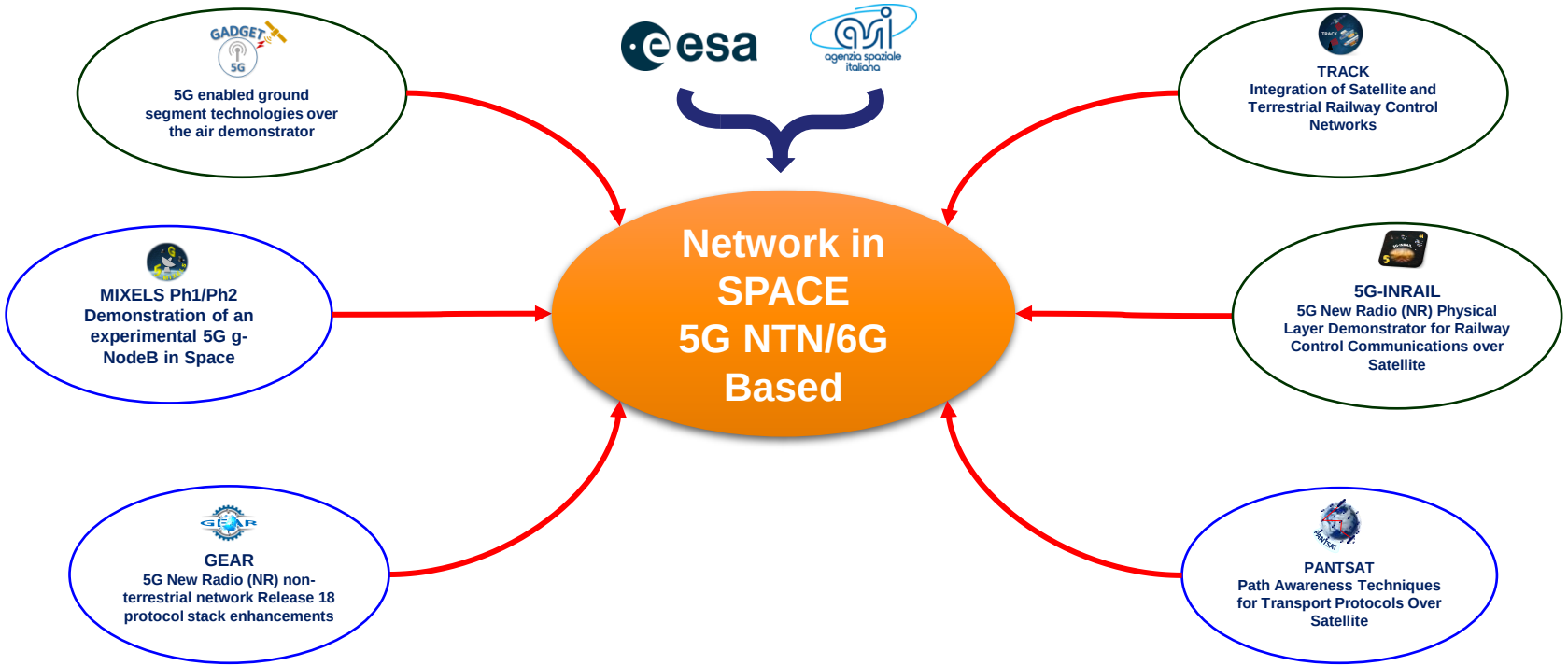
Date: 5/02/2026
Ref: O-RAN Alliance Workshop
Template: 83230347-DOC-TAS-EN-011

INTEGRATED SPACE-EARTH NETWORK: THE SCHEME



Ref: ESA Project "*Path Awareness Techniques for Transport Protocols over Satellite" (ESA Contract n. 4000142081/23/NL/EG)*

TAS-I/DTI INVOLVEMENT AND BACKGROUND



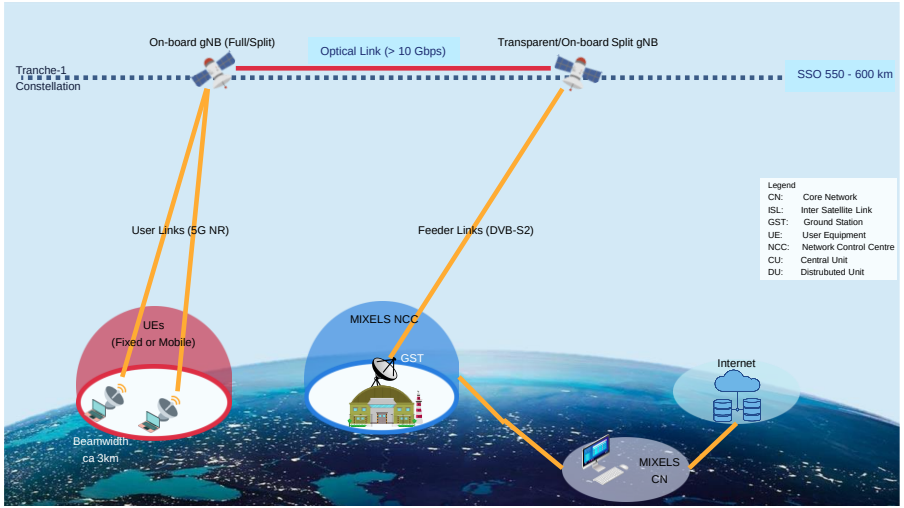
Date: 5/02/2026
Ref: O-RAN Alliance Workshop
Template: 83230347-DOC-TAS-EN-011

AN ACTUAL CASE: THE MIXELS PROJECT

/// “Demonstration of an Experimental 5G g-NodeB in Space” (MIXELS) Project has the objective to develop and demonstrate in orbit an experimental 5G g-NodeB distributed between a regenerative (processed) payload and a satellite gateway. The demonstration will focus on showing the main functionalities of a gNodeB for New Radio Non-Terrestrial Network from LEO.

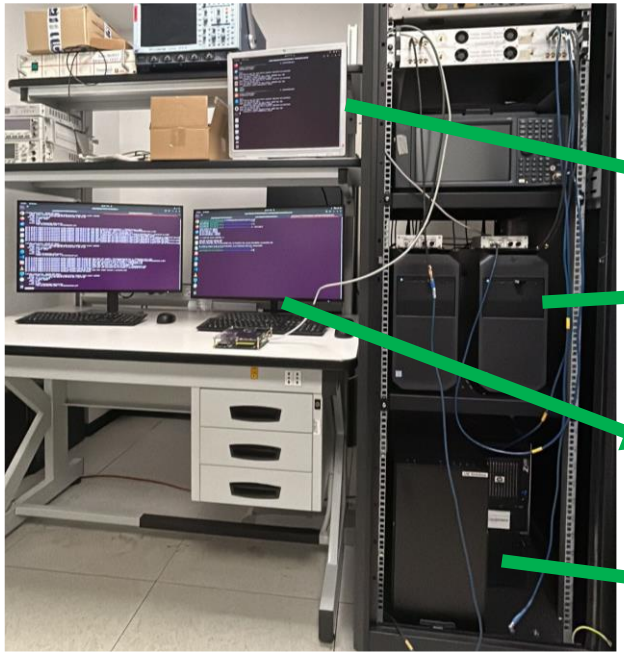
/// In Perspective, the results of MIXELS Project will be able to be extended also towards MEO and GEO in view of the actual implementation of space networks combined and interacting with the terrestrial network in seamless and transparent way.

/// Currently the Phase 1 has been successfully concluded



Date: 5/02/2026
Ref: O-RAN Alliance Workshop
Template: 83230347-DOC-TAS-EN-011

LABORATORY TESTBED @ THALES ALENIA SPACE ITALIA



MBCE and Spectrum Analyser
Channel Emulator RF and Spectrum Analyser for Monitoring

Channel Simulator
Delay Simulator at IP packets running on dedicated workstation

Workstations and SDRs
GNB and CN software running on two different Workstation.
SDR ETTUS B210 available

Xilinx Evaluation Board
Evaluation Board that must emulate the on-board processing of the in-orbit satellite

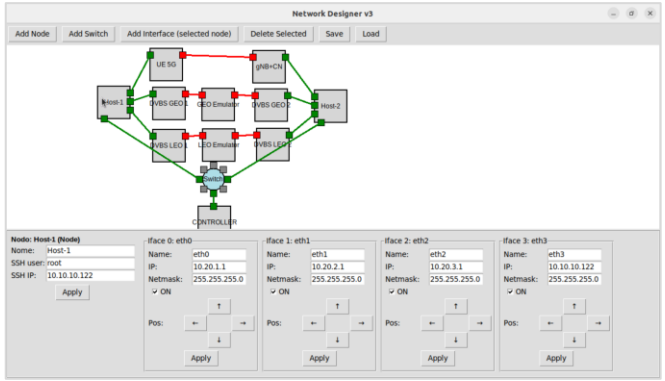
UE
5G NTN UE

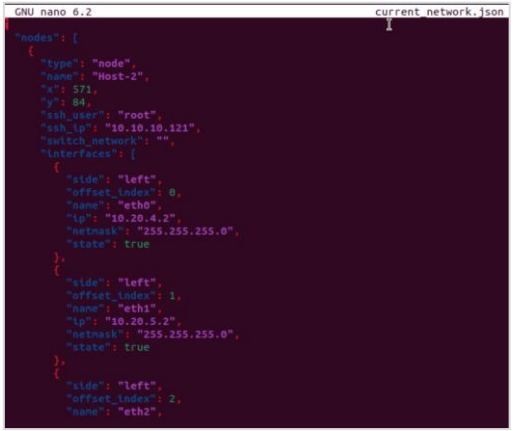
LABORATORY TESTBED: DESIGNER NETWORK TOOL

The **Designer Network Tool (DNT)** has been implemented. This defines the network to be simulated in the laboratory, i.e. it defines:

- the number of nodes
- the interfaces
- the networks and subnets
- the connections

The tool is essential for structuring the network architecture in an **intuitive and visual** approach.
The output of DNT is a **JSON file** containing all the network configuration information through a GUI.

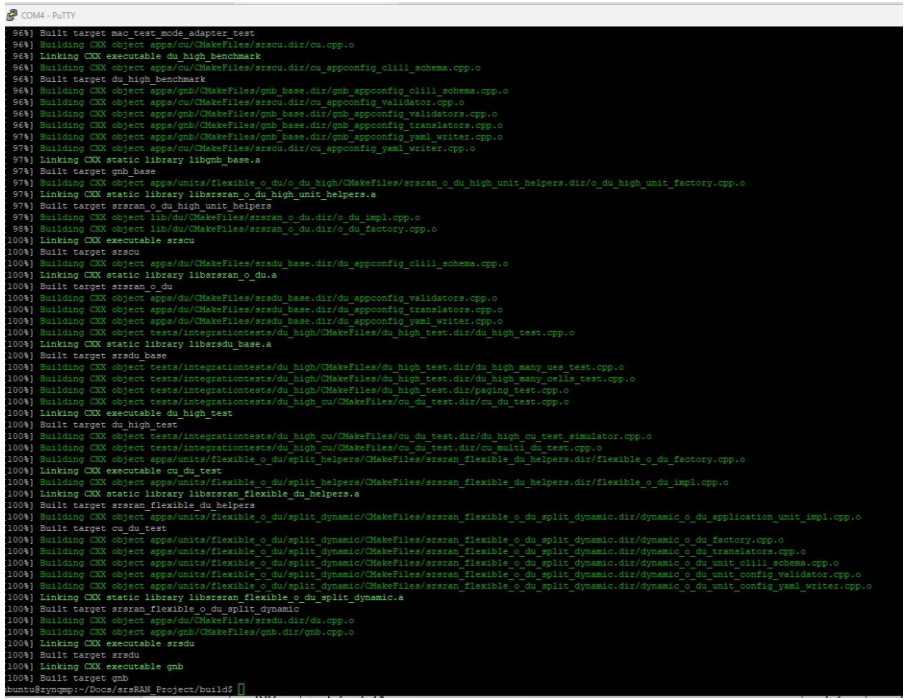


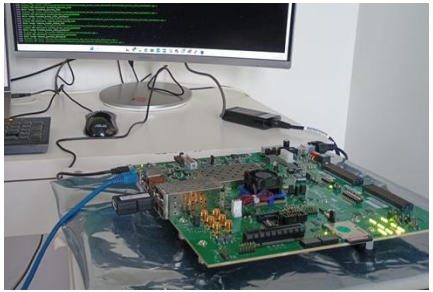


Date: 5/02/2026
Ref: O-RAN Alliance Workshop
Template: 83230347-DOC-TAS-EN-011

LABORATORY TESTBED: MIXELS SETUP

SW porting on Xilinx ZCU102 Evaluation Board





Installation an embedded version of the Canonical Ubuntu 22.04 Operative System

- The Operative System has been installed on the Evaluation Board
- The Development environment has been set-up
- The srsRAN_Project software has been compiled on the Evaluation Board demonstrating its right functionality

GEAR PROJECT (5G-NTN REL. 18 VERSUS REL. 19)

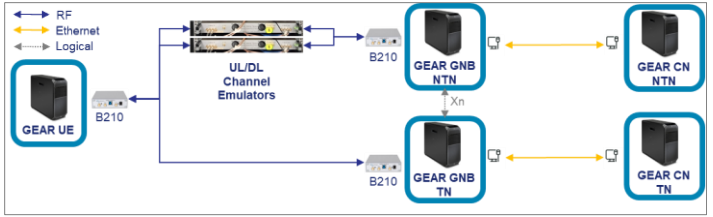
/// To develop the protocol stack for Release 18 enhancements related to 5G New for Radio (NR) for Non-Terrestrial Networks. The protocol stack development is tested in a dedicated testbed in which both User Equipment (UE) and g-NodeB (gNB) features and operational procedures, along with the Core Network (CN), are verified.

/// In line with 3GPP Rel.18, the following items are considered:

- **Payload, UE and Spectrum**: FR2 and extended FR1; VSAT in FR2; Enhancement for FR1 handled terminals
- **SA and CT**: System with satellite backhaul; support for discontinuous coverage
- **RAN**: uplink coverage enhancement; network verified UE location via multi-RTT from a single satellite; NTN-TN mobility; NTN-TN mobility and service continuity.

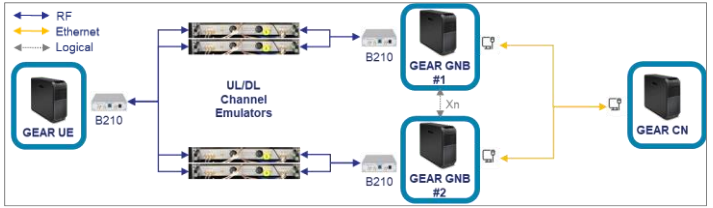
/// **Cell handover:**

- **TN-NTN mobility**



/// **Cell handover:**

- **NTN-NTN mobility (inter-gNB/-cell/-beam over the Xn interface)**



5G New Radio (NR) non-terrestrial network Release 18 protocol stack enhancements (GEAR)

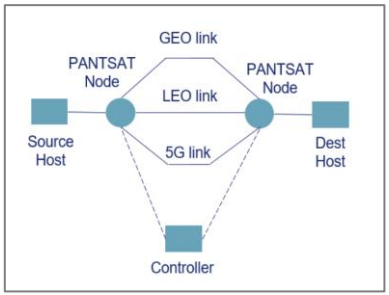
Date: 5/02/2026
Ref: O-RAN Alliance Workshop
Template: 83230347-DOC-TAS-EN-011

PANTSAT PROJECT (DEMONSTRATOR FOR SPACE NETWORK)

The objective is to develop and test Path Aware Networking (PAN) techniques for LEO, MEO or GEO systems with dynamic bandwidth allocation and oversubscription and for hybrid satellite-terrestrial networks with multipath. The new protocols is implemented in software and verified via a Demonstrator capable also to validated outcome over the air.

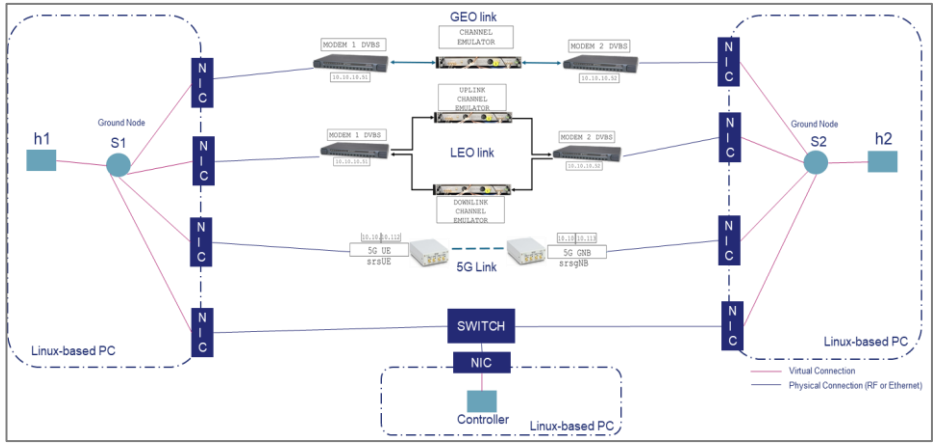
In detail, the demonstrator verify that:

- the Controller communicates network data correctly.
- the various nodes are able to autonomously select the path to follow (Path-Aware Networking).
- The nodes respond appropriately to changes in the system state.
- The Controller's security procedures are correctly enforced.



Three possible path are considered: GEO, LEO and TN)

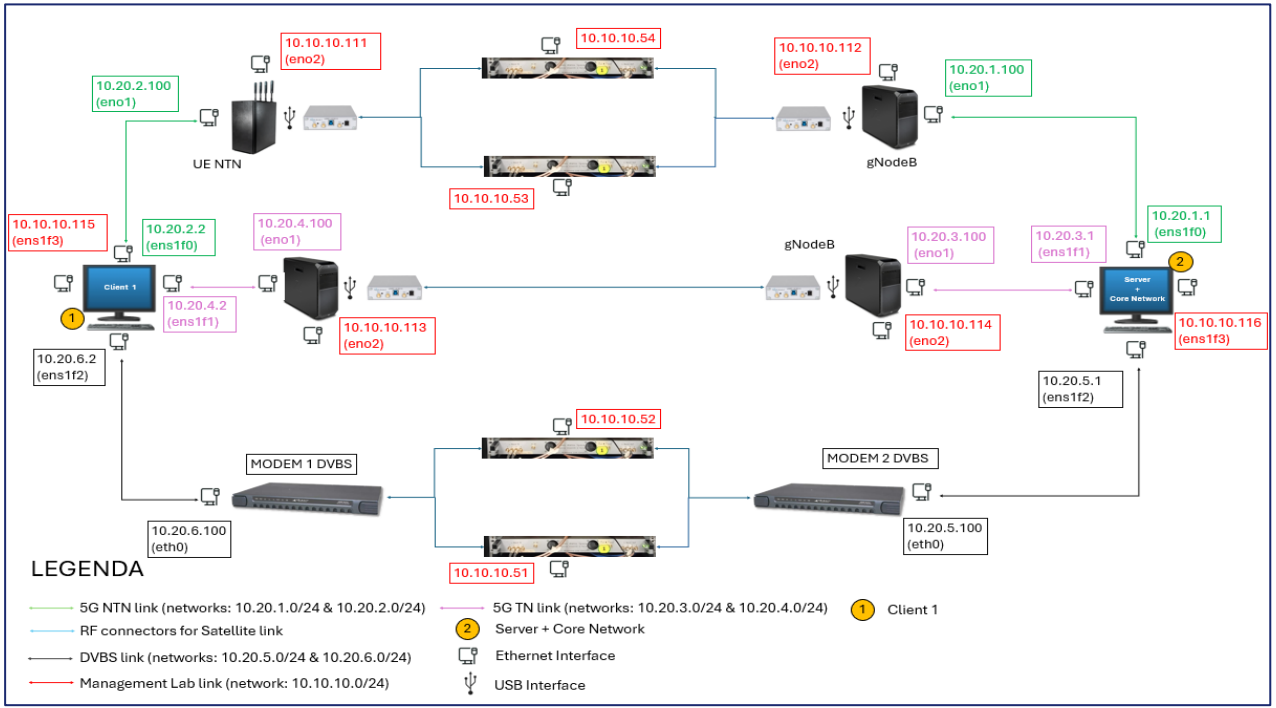
The evaluated parameters are: Delay; Congestion Leve and Link reliability



Path Awareness Techniques for Transport Protocols over Satellite (PANTSAT)

Date: 5/02/2026
Ref: O-RAN Alliance Workshop
Template: 83230347-DOC-TAS-EN-011

INTEGRATED TEST SYSTEM FOR 5G NR NTN AND DVBS2 TESTING



Laboratory testbed has been improved to be a Testing Hub for all protocol experimentation in the space.

In the diagram three different links are integrated:

- **5G NTN**
- **Terrestrial 5G**
- **DVB-S2**

This configuration enables the study of advanced concepts such as:

- *In-space routing*
- *Software Defined Networking (SDN)*
- *Network Orchestration*
- *Network Controllers.*

Date: 5/02/2026
Ref: O-RAN Alliance Workshop
Template: 83230347-DOC-TAS-EN-011

CONCLUSION

/// The MIXELS project is demonstrating the functionalities of a regenerative gNB in space using two experimental LEO satellites interconnected by optical ISL

/// Different functional split scenarios between space and ground and in space have been verified in laboratory

/// Results are expected to provide valuable insights about NTN functionalities envisaged in 3GPP Rel. 17 and 18 and could be used for future standardization activities

Vincenzo SCHENA
Head of R&D Dept. at Domain Telecommunication Italy (DTI)

Tel. +39 06 4151 2523
Mob.: +39 335 7266021
E-mail: vincenzo.schena@thalesaleniaspace.com