KEYSIGHT

Joint O-RAN ALLIANCE and ESA Summit
Non-Terrestrial Networks (NTN)

O-RAN Enabling NTN Deployments
Opportunities and Synergies

Sky to Lab

3GPP A GLOBAL INITIATIVE | **O-RAN** ALLIANCE

Eng Wei Koo
EngWei.Koo@keysight.com
Director of Radio Access Networks (RAN) Standards and Strategy
O-RAN ALLIANCE Test and Integration Focus Group (TIFG) Co-chair
3GPP RAN Plenary Delegate
February 5, 2026

Presentation Outline

Satellite Communications Evolution

Challenges

Sky-to-Lab Case Studies

Summary

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Satellite Communications Evolution
Rapid Acceleration towards 3GPP NTN and Creating Opportunities for Open RAN

Proprietary Non-3GPP Vertical solutions	**Un-modified 3GPP** Legacy phone Direct to Cell / Direct to Device	**3GPP Rel-17-20 and Beyond**	
		IoT NTN	NR NTN
Commercial Timelines — Existing	Today & Ramping Up	2024 onwards	2027 onwards
SOS messaging, Emergency	Messaging, Voice, Data	Messaging, IoT	Inter-Satellite Link (ISL) Messaging, Voice, Broadband, IoT

- **Un-modified 3GPP:**
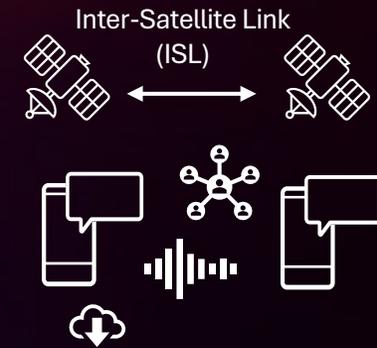 - Terrestrial Bands
  - Transparent "Bend Pipe"
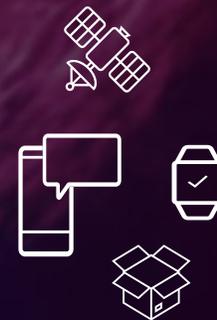
- **3GPP Rel-17-20 and Beyond:**
  - S, L, Ka (17.3 – 30GHz), Ku (10.7-14.5 GHz)
  - Transparent, Regenerative (complete gNB)
  - "Store and Forward" (S&F)

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Standardization
Progress and Opportunities for Improvements in O-RAN ALLIANCE

	3GPP	O-RAN ALLIANCE
5G-Advanced	• Started in Release 17 • Release 20 work in progress	• Started study as part of Release 005 (transparent mode) • Release 006 work in progress (study for regenerative mode, normative work for transparent and regenerative)
6G	• Release 20 study in progress	• Release 006 study is planning in progress

	2023	2024	2025	2026	2027	2028	2029	2030	2031
		Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q4

3GPP

Release 20 (6G Study)

Release 21 (1st 6G Specifications) — TBD

6G Use Cases Workshop May 2024

TSG 6G Workshop 2 days - Mar 10-11, 2025

Rel-20 6G Study Complete June 2027

Rel-21 6G Timeline To be decided in Jun 2026

Rel-21 6G Freeze Date No Earlier than Mar 2029

O-RAN

O-RAN Rel-005

[1]O-RAN Rel-006 (inc. 6G Stage 1 and 2) — TBD

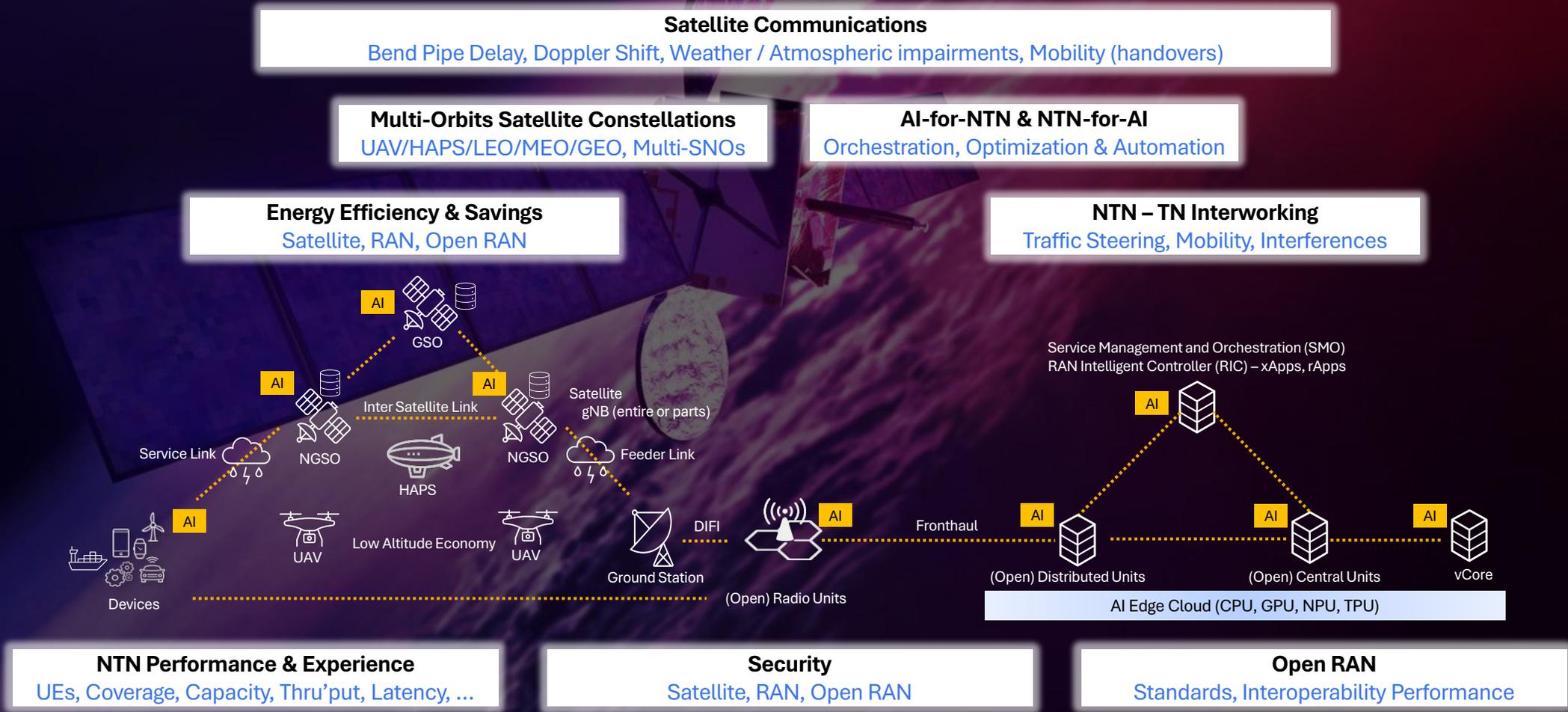[1]O-RAN Rel-007 (inc. 6G Stage 3) — TBD

[1] Release 006 and 007 to be planned in O-RAN ALLIANCE

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Challenges - Satellite, NTN, Open RAN and AI

How Do We Test These on the Ground (before even having Satellites in Orbit)?

Satellite Communications
Bend Pipe Delay, Doppler Shift, Weather / Atmospheric impairments, Mobility (handovers)

Multi-Orbits Satellite Constellations
UAV/HAPS/LEO/MEO/GEO, Multi-SNOs

AI-for-NTN & NTN-for-AI
Orchestration, Optimization & Automation

Energy Efficiency & Savings
Satellite, RAN, Open RAN

NTN – TN Interworking
Traffic Steering, Mobility, Interferences

- AI — GSO
- AI — AI — Inter Satellite Link
- Service Link — NGSO
- NGSO — Satellite gNB (entire or parts)
- HAPS
- Feeder Link
- AI — Devices
- UAV — Low Altitude Economy — UAV
- Ground Station
- DIFI
- AI — (Open) Radio Units
- Fronthaul
- Service Management and Orchestration (SMO)
- RAN Intelligent Controller (RIC) – xApps, rApps
- AI
- AI — (Open) Distributed Units
- AI — (Open) Central Units
- AI — vCore
- AI Edge Cloud (CPU, GPU, NPU, TPU)

NTN Performance & Experience
UEs, Coverage, Capacity, Thru'put, Latency, ...

Security
Satellite, RAN, Open RAN

Open RAN
Standards, Interoperability Performance

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Challenges - Satellite Communications

Atmospheric Effects at Higher Frequencies > 10 GHz (Ka, Ku Bands)

Atmospheric Attenuation

Reduction in power of a signal as it passes through the atmosphere (e.g., rains, cloud/fog, storms etc.) with slower rate of change
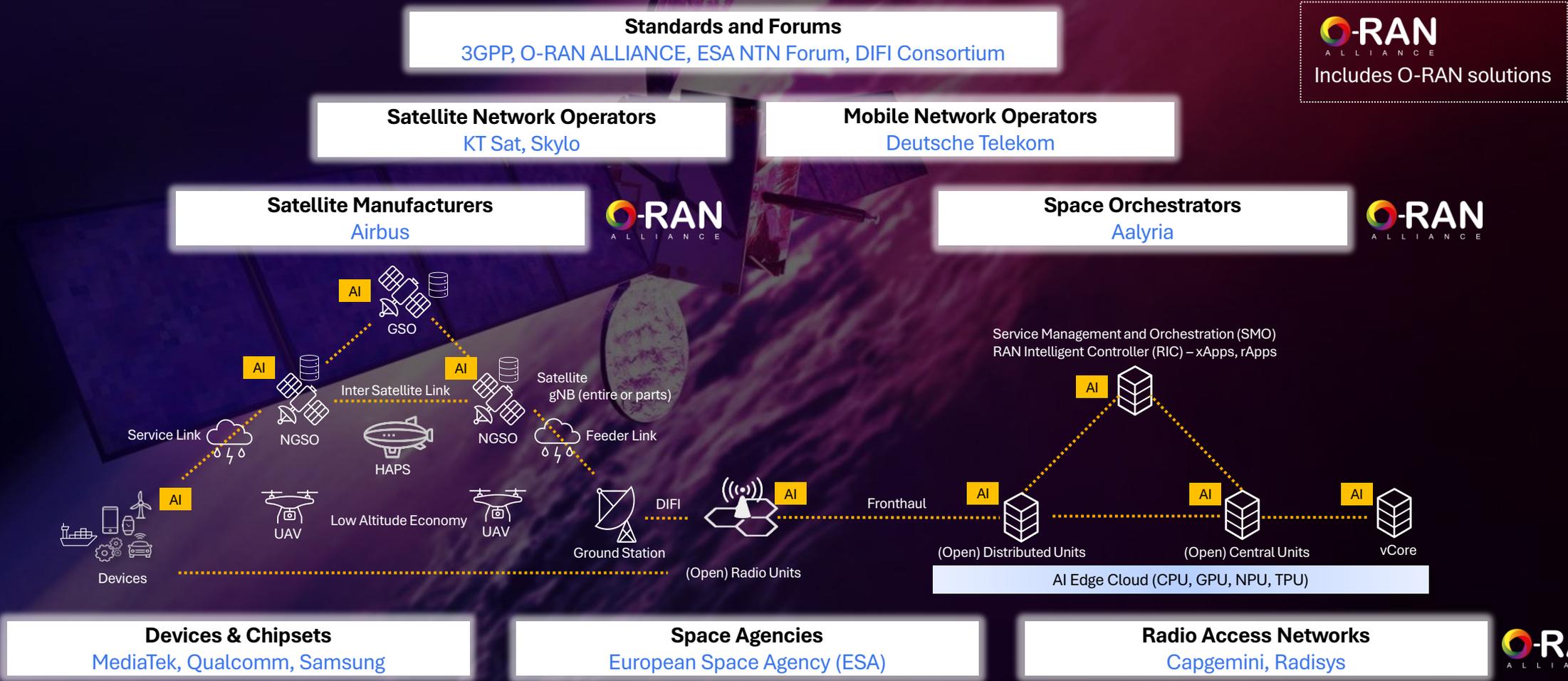
Tropospheric Scintillation

Rapid, random fluctuations in the amplitude, phase, or angle of arrival of a signal (e.g., turbulence in the lower troposphere (up to 10 km altitude), typically due to variations in temperature, humidity, and pressure.)
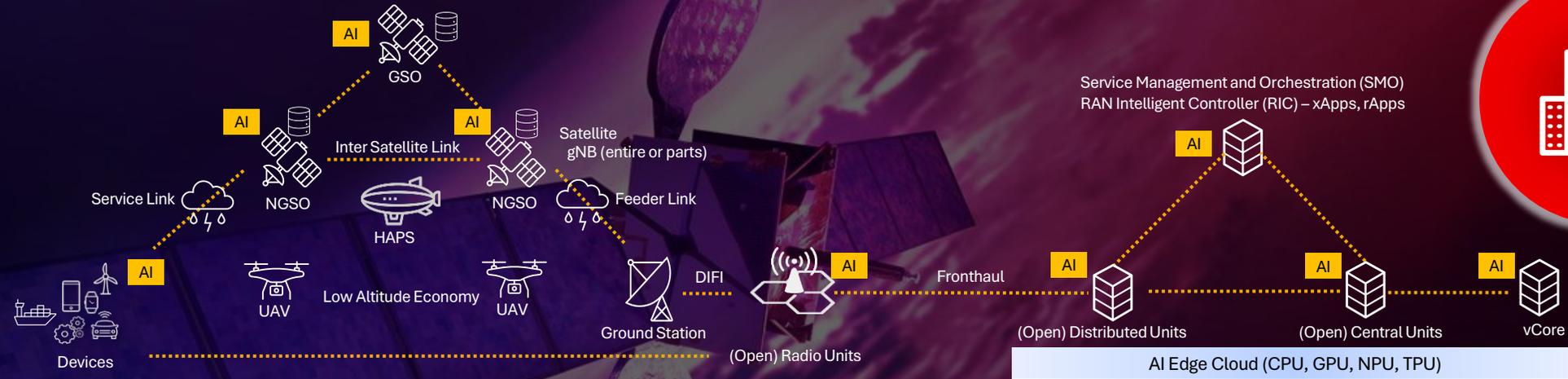

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Keysight Enabling NTN Development Across the Ecosystem
Examples of Industry Collaborations - Public Announcements

O-RAN ALLIANCE
Includes O-RAN solutions

Standards and Forums
3GPP, O-RAN ALLIANCE, ESA NTN Forum, DIFI Consortium

Satellite Network Operators
KT Sat, Skylo

Mobile Network Operators
Deutsche Telekom

Satellite Manufacturers
Airbus

Space Orchestrators
Aalyria

AI

GSO

AI

AI

Inter Satellite Link

Satellite
gNB (entire or parts)

Service Link

NGSO

HAPS

NGSO

Feeder Link

AI

UAV

Low Altitude Economy

UAV

DIFI

AI

Fronthaul

Service Management and Orchestration (SMO)
RAN Intelligent Controller (RIC) – xApps, rApps

AI

AI

AI

AI

Devices

Ground Station

(Open) Radio Units

(Open) Distributed Units

(Open) Central Units

vCore

AI Edge Cloud (CPU, GPU, NPU, TPU)

Devices & Chipsets
MediaTek, Qualcomm, Samsung

Space Agencies
European Space Agency (ESA)

Radio Access Networks
Capgemini, Radisys

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Keysight Enabling NTN Development Across the Ecosystem
Sky-to-Lab Digital Twin Powered Portfolio

AI — GSO

AI — Inter Satellite Link — AI — Satellite gNB (entire or parts)

Service Link — AI

NGSO — HAPS — NGSO — Feeder Link

Low Altitude Economy

UAV — UAV

AI — Devices

DIFI — AI — Ground Station

(Open) Radio Units — Fronthaul

Service Management and Orchestration (SMO)
RAN Intelligent Controller (RIC) – xApps, rApps

AI

AI — (Open) Distributed Units

AI — (Open) Central Units

AI — vCore

AI Edge Cloud (CPU, GPU, NPU, TPU)

Simulate | **Emulate and Troubleshoot** | **Field Trials & Deployments**

UE ← Channel → NB

System Simulation	NB testing	NB & UE testing	UE testing	Wireless Network Testing
Wireless Network Simulator EXata	**UE Emulator** UeSIM	**Channel Emulator** PROPSIM	**Base Station Emulator** UXM	**Network Testing** NEMO

Troubleshooting	SMO/RIC, xApps, rApps testing
Wireless Analyzer WaveJudge	**UE+O-RAN Emulator** RICtest

O-RAN ALLIANCE
Includes O-RAN solutions

O-RAN ALLIANCE

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Sky-to-Lab Case Studies - Explore Advanced Capabilities of 5G NTN

Airbus UpNext SpaceRAN Demonstrator (1) Ground (2) In Orbit Platforms

[Jan 12, 2026] Airbus led (inc. Keysight) consortium plan testing advanced software-defined satellite technology and 5G connection on two different platforms

- The first is a ground demonstration that will simulate a two-satellite constellation in low-Earth orbit (LEO), testing key features like beam and satellite handovers, which are crucial for maintaining smooth and continuous connection.

- The second is an in-orbit demonstration that will place a 5G non-terrestrial network payload on an Airbus LEO satellite, to act as a 5G base station in space.
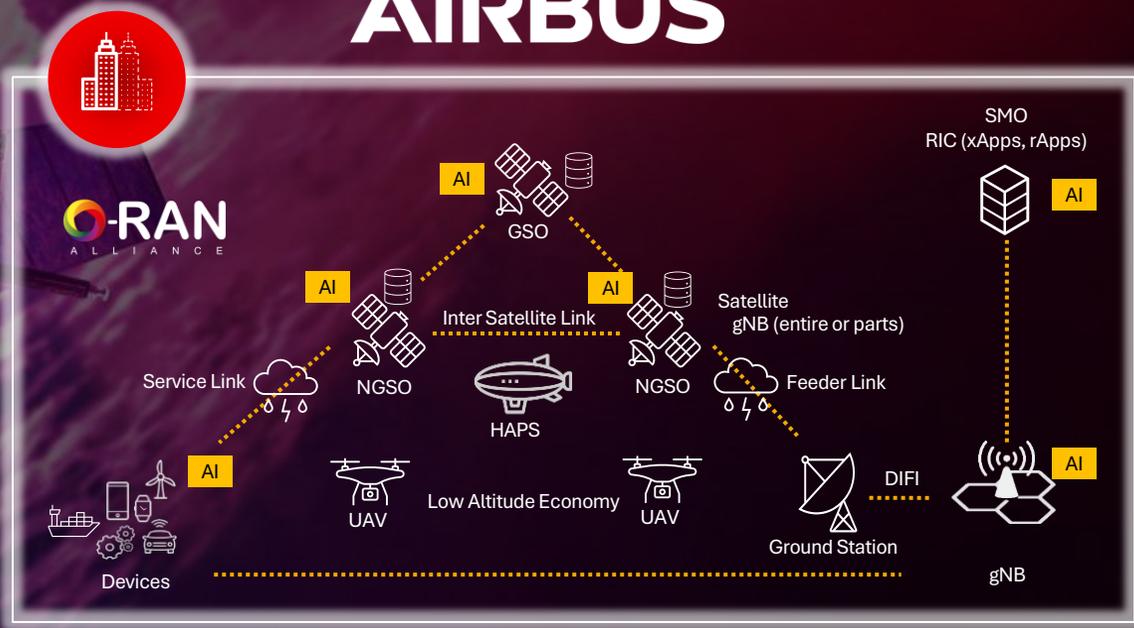
E2E testing

UE Emulator
UeSIM

Channel Emulator
PROPSIM

[Source: Airbus launches demonstrator to test global 5G connectivity in orbit]
[Source: Expanding 5G connectivity with the Airbus UpNext SpaceRAN demonstrator]
[Source: Keysight Collaborates on Airbus UpNext SpaceRAN Demonstrator to Advance 5G NTN Innovation]

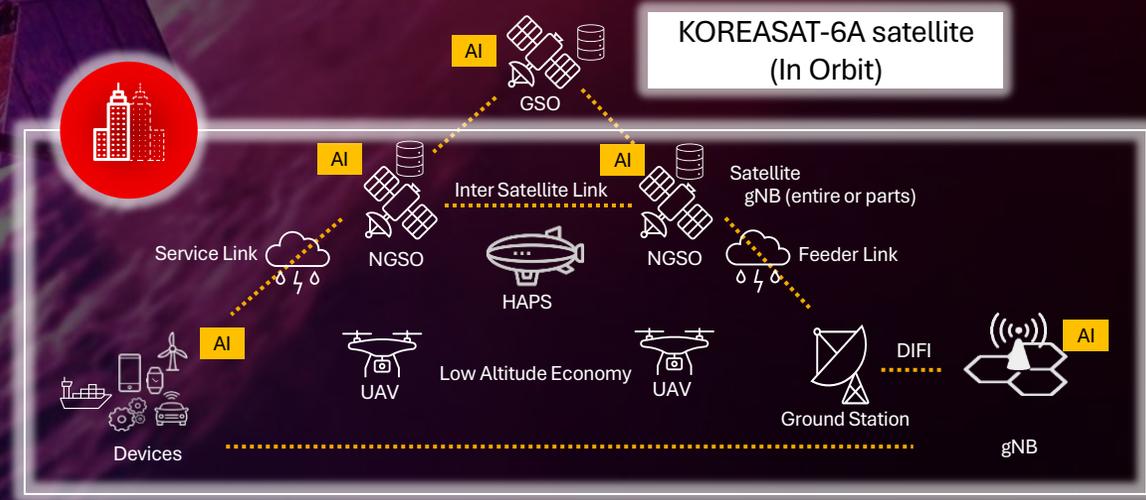Figure shown for illustrative purpose only and therefore may not be representative of the actual test topology

Sky-to-Lab Case Studies - Multi-Orbits Satellite Constellations

Live Multi-Orbit Proof-of-Concept Shows GEO to LEO Handover

[Dec 11, 2025] Keysight and KT SAT have demonstrated a successful non-terrestrial network (NTN) GEO to LEO handover using the KOREASAT-6A satellite in-orbit at KT SAT's Kumsan Satellite Network Operation Center in Korea

- The demonstration was performed over a live Ku-band GEO connection (DL ~12.3 GHz / UL ~14.4 GHz), marking a major milestone toward testing the newly standardized 3GPP Rel-19 Ku-band NTN spectrum.

kt sat

KOREASAT-6A satellite (In Orbit)

GSO

Inter Satellite Link

Satellite gNB (entire or parts)

Service Link

NGSO

NGSO

Feeder Link

HAPS

Low Altitude Economy

UAV

UAV

DIFI

Ground Station

gNB

Devices

UEs Connected to LEO & GEO
UE Emulator
UeSIM

NW Connected to LEO & GEO
Base Station Emulator
UXM

[Source: Keysight and KT SAT Achieve Industry-First Multi-Orbit NTN Handover Between GEO Satellite and Emulated LEO Link]
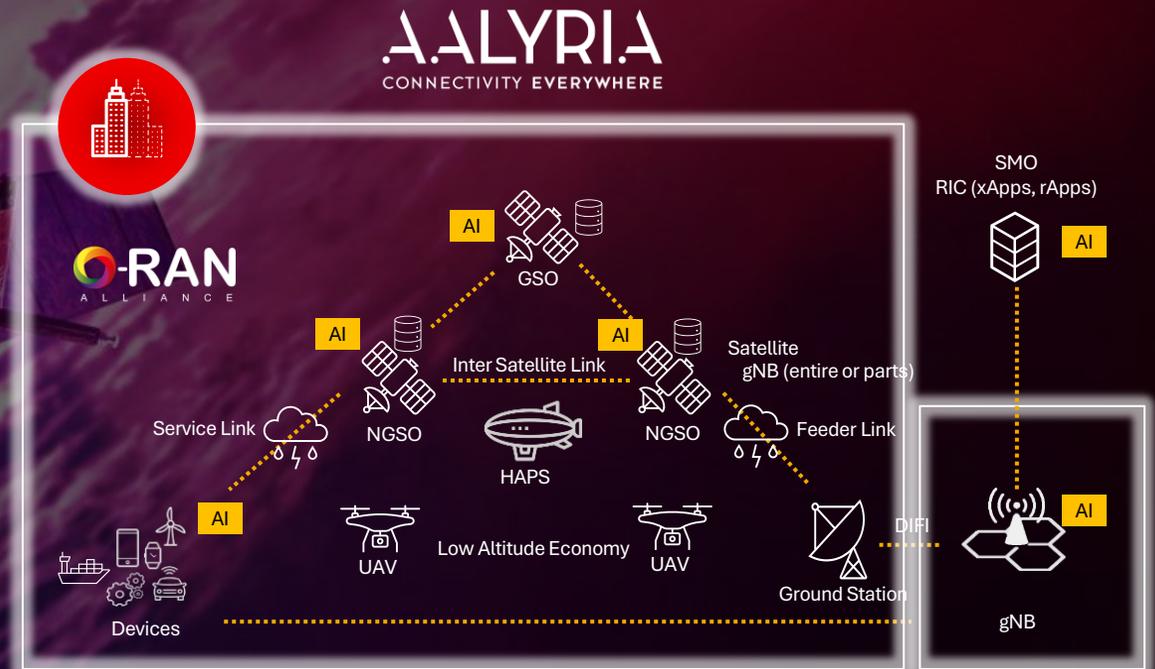
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Sky-to-Lab Case Studies - Space Orchestration

Industry 1st 3GPP NTN AI-RIC test bed with Digital Twins

[MWC Barcelona 2025] Aalyria and Keysight co-developed industry 1st 3GPP NTN AI-RIC test bed with Digital Twins

- Showcased how Spacetime dynamically manages radio resources and mobility in 5G NTN.

- Highlighted how Spacetime's predictive AI models work with O-RAN interfaces from Keysight's simulated NTN RAN to provide an accurate, end-to-end view of network conditions—exceeding traditional 5G channel estimation mechanisms.

SMO/RIC, xApps, rApps testing
UE+O-RAN Emulator
RICtest

[Source: Aalyria and Keysight Collaborate to Advance 5G Non-Terrestrial Networks]

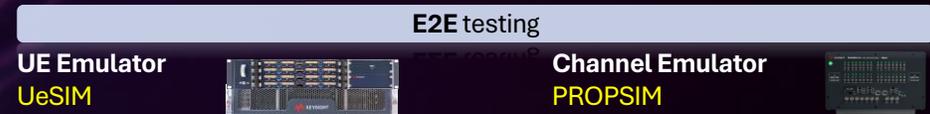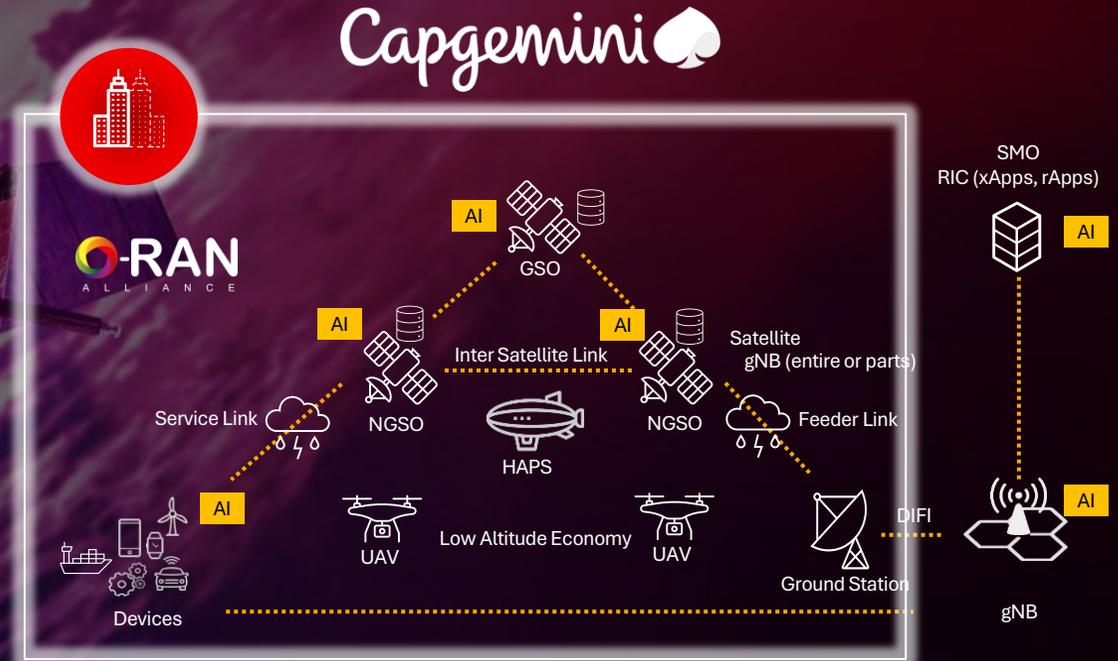Figure shown for illustrative purpose only and therefore may not be representative of the actual test topology

Sky-to-Lab Case Studies - Radio Access Network Test & Optimization

Commercial Readiness of Regenerative and Transparent NTN O-RAN

[MWC Barcelona 2025] Capgemini and Keysight demonstrated NTN O-RAN gNB commercial readiness

- End-to-end validation of regenerative non-terrestrial network (NTN) Capgemini's 5G O-RAN CU/DU framework, for robust operations in non-geostationary satellite orbit (NGSO) and low earth orbit (LEO) constellations

- Addresses dynamic satellite movement and complex beamforming challenges, enhancing global connectivity and network performance

E2E testing

UE Emulator
UeSIM

Channel Emulator
PROPSIM

[Source: Keysight and Capgemini Accelerate Validation of Regenerative and Transparent Non-Terrestrial Network RAN]

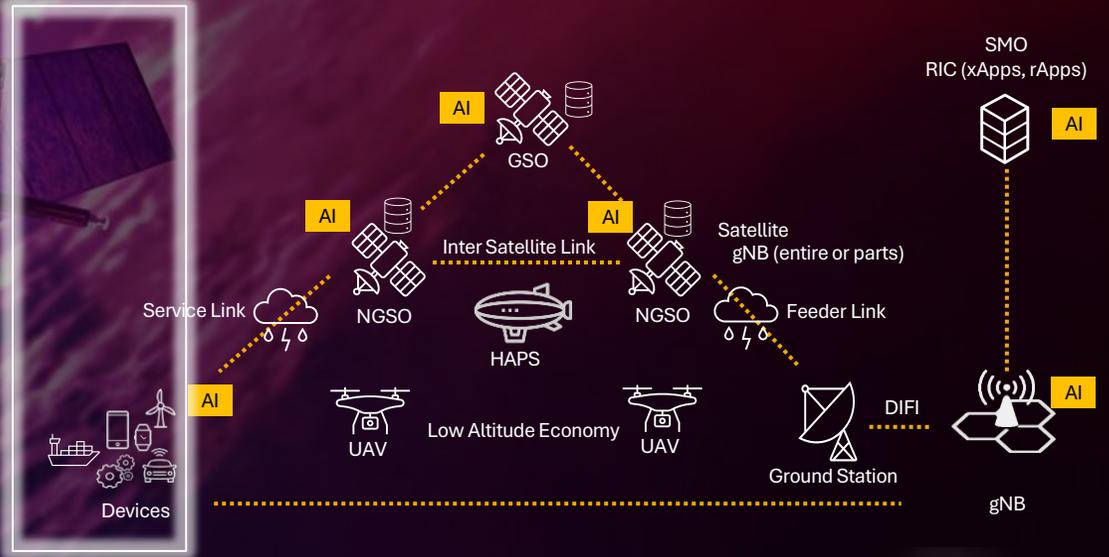Figure shown for illustrative purpose only and therefore may not be representative of the actual test topology

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Sky-to-Lab Case Studies - Field Trials and Deployments
Ground Truth with Active Testing and Monitoring

Keysight NTN / TN probing solution supporting both active testing and monitoring use models used for

- Satellite coverage audit and usable signals

- Performance and QoE testing

- NTN impact on Terrestrial

- Interference claims

- Satellite D2C (Direct to Cell) Schedule Validation – Planned versus Actual Schedules

- UE and chipsets readiness

SMO
RIC (xApps, rApps)

GSO

AI

AI

AI

Inter Satellite Link

Satellite
gNB (entire or parts)

NGSO

NGSO

Feeder Link

Service Link

HAPS

AI

UAV

Low Altitude Economy

UAV

DIFI

Ground Station

gNB

Devices

Wireless Network Testing

Network Testing
NEMO

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Summary
Opportunities, Challenges and Call to Actions

Satellite Communications Evolution

We are seeing a rapid acceleration towards 3GPP NTN

- Pre-Rel 17 unmodified LTE, NR
- NTN NB/IoT in service
- NTN NR services expected 2027

Therefore, a key opportunity for Open RAN enabling NTN deployments

- O-RAN standardization 5G towards 6G work is needing to be accelerated to catch the deployment timelines – call for like-minded companies to join us

Challenges

How to test, optimize and assure NTN solutions throughout its lifecycle

- Satellite Communications
- Multi-Orbits Satellite Constellations
- AI-for-NTN & NTN-for-AI
- Energy Efficiency & Savings
- NTN – TN Interworking
- NTN Performance & Experience
- Open RAN

Sky-to-Lab Case Studies

Keysight Sky-to-Lab Digital Twin Powered portfolio enabling NTN Development across the ecosystem

- Airbus UpNext SpaceRAN Demonstrator Lab / Live Platforms
- KT Sat Live Multi-Orbit PoC on GEO to LEO Handover
- Aalyria Space Orchestrator
- Capgemini Regenerative and Transparent NTN O-RAN
- Field trials and deployments

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You Dream – We Test

KEYSIGHT