

Rakuten's Perspectives on NTN

**New Businesses for Telecom Operators, Architectural
Evolution, Standard and Opportunities with O-RAN**

**Rakuten Mobile
Rakuten Symphony**

O-RAN NTN Workshop – Rome, Feb. 2026

Overview

1

Rakuten's NTN Business and Market vision

2

NTN Use cases, Architecture evolution and Standardization

3

Opportunities and Potential Solutions with O-RAN including RIC for NTN in 5GA and 6G Era

Rakuten's NTN business and market vision



Rakuten SAIKYO SATELLITE Service

Powered by [AST SpaceMobile](#)

*Aiming to provide strongest satellite service.

March 3, 2020

Rakuten and AST SpaceMobile* announce strategic partnership



*Formerly AST & Science. Image is for illustrative purposes.

AST SpaceMobile's Strategic Partners



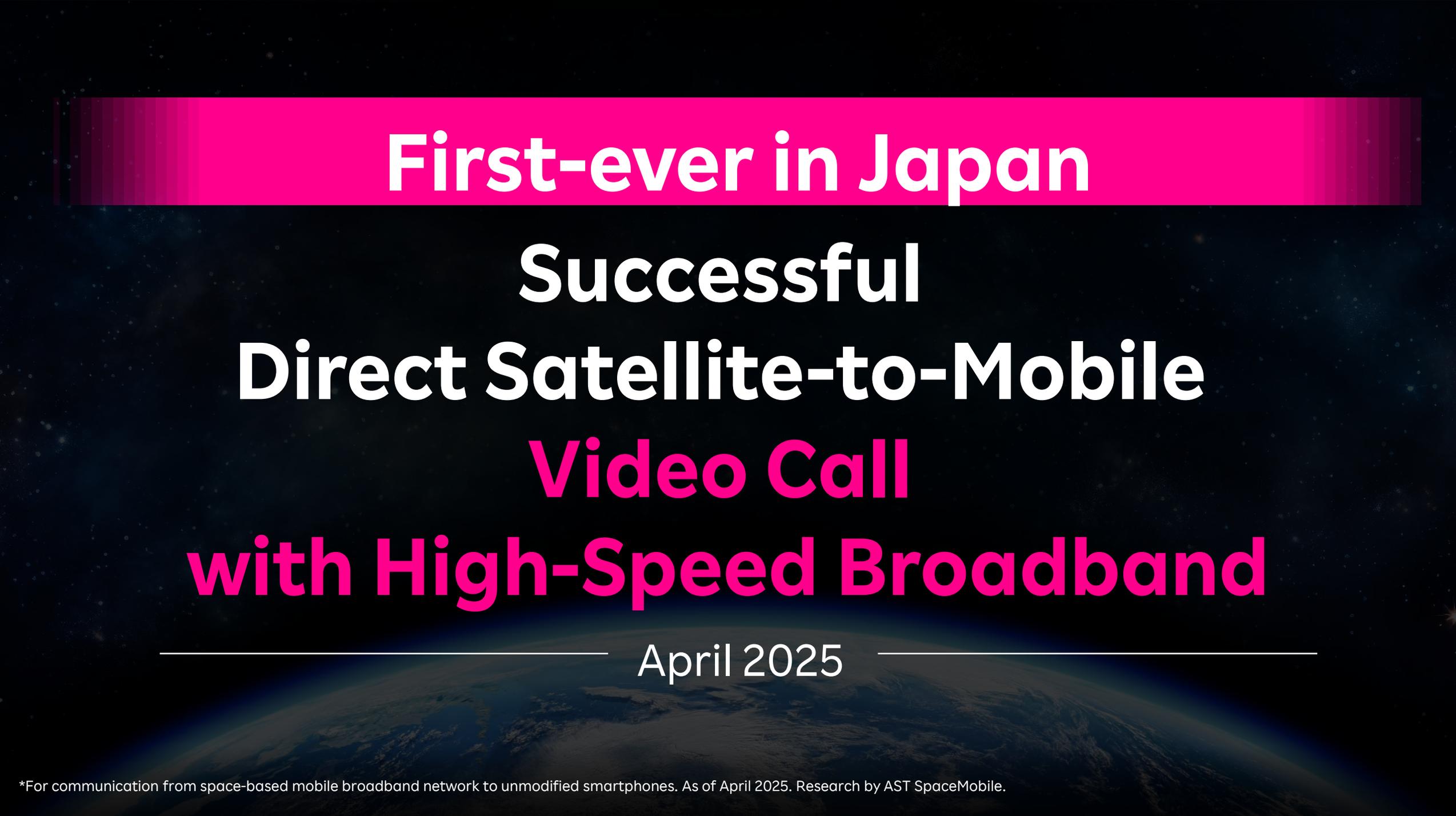
AMERICAN TOWER®



April 21, 2023 (JST)



Successful completion of **world's first** direct satellite to mobile voice call from Midland, Texas*



First-ever in Japan

Successful

Direct Satellite-to-Mobile

Video Call

with High-Speed Broadband

April 2025

September 12, 2024 (JST)

Successful launch and unfolding of 5 commercial BlueBird satellites (Block 1)

Block 2 satellites:
Giant antennas spanning
223m²

Strengths of Rakuten Saikyo Satellite Service

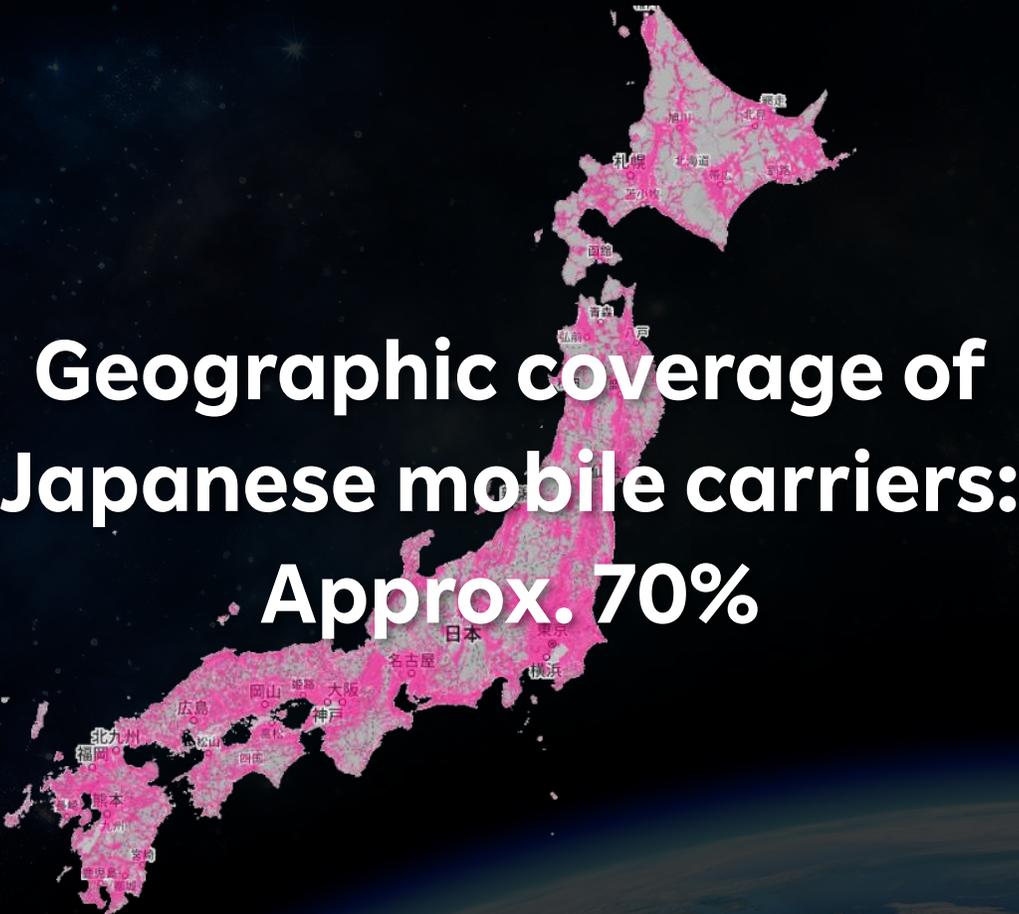
	Rakuten SAIKYO SATELLITE Service <small>Powered by AST SpaceMobile</small>	Company S
Antenna size	64.4m ² (Block 2: 223m) <small>Approx. 36x of Comp. S</small>	Approx. 6.2m ² <small>*As of January 2024</small>
Features	Text messages, data, voice calls, video streaming services, social media apps , other native mobile broadband capabilities Broadband connectivity	Text messages, data, voice calls
Compatible devices	Almost all smartphones *	Select smartphones

*Supports all LTE devices (Devices compatible with Rakuten Mobile and verified for operation on the network recommended).

*Aiming to provide strongest satellite service.

Rakuten SAIKYO SATELLITE Service

Powered by AST SpaceMobile



Geographic coverage of
Japanese mobile carriers:
Approx. 70%



Toward
100%
geographical coverage

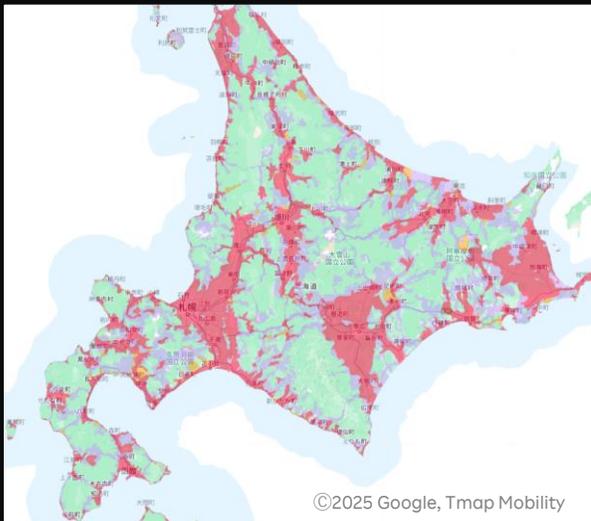
*Coverage in territorial waters
under consideration.

Comparison of High-Speed Broadband Connectivity using LEO satellites

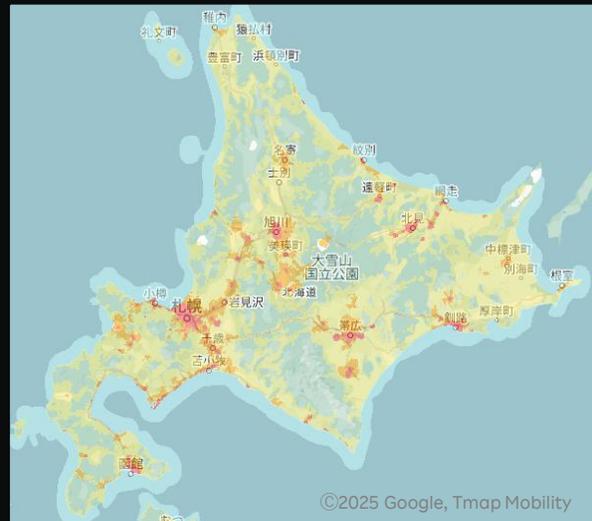
Example: Hokkaido

Rakuten
SAIKYO SATELLITE
Service
Powered by ASTSpaceMobile

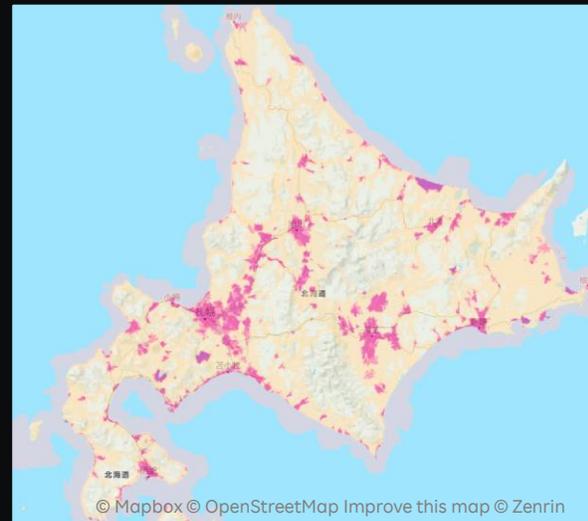
Simulation at time of service provision



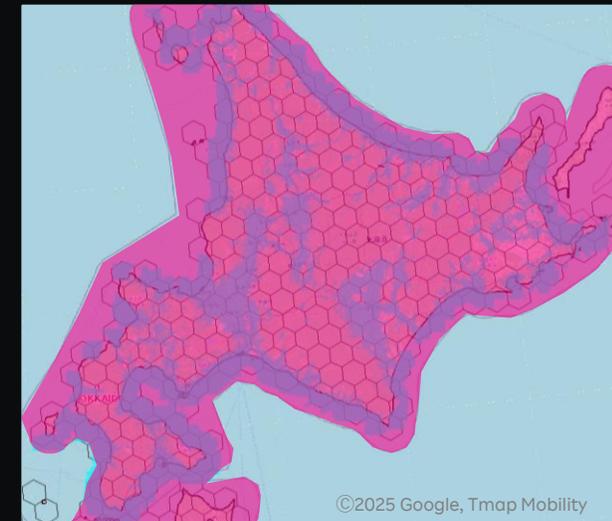
*1



*2



*3



To cover all of Japan

* Coverage in territorial waters under consideration.

Sources: Data from April 22, 2025

*1. NTT docomo: https://www.docomo.ne.jp/area/service_area/?icid=CRP_AREA_service_area_error_to_CRP_AREA_service_area#sec_service-area-map

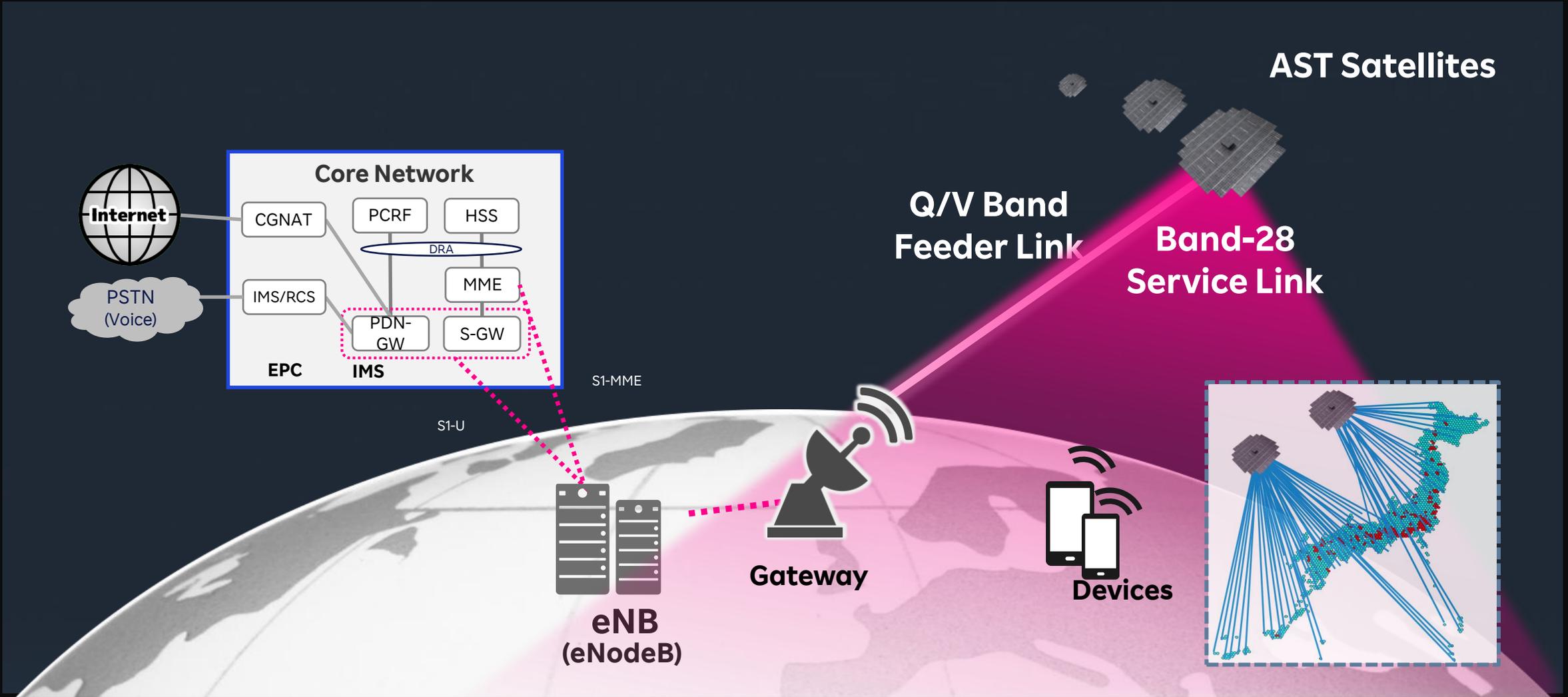
*2. KDDI: <https://www.au.com/mobile/area/map/>

*3. SoftBank: <https://www.softbank.jp/mobile/network/area-map/>

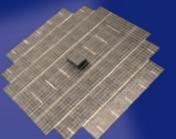
CONFIDENTIAL

*Aiming to provide strongest satellite service.

High Level D2D Technology Overview



AST SpaceMobile Usage



Satellite

When using Rakuten network

Use Rakuten network where available

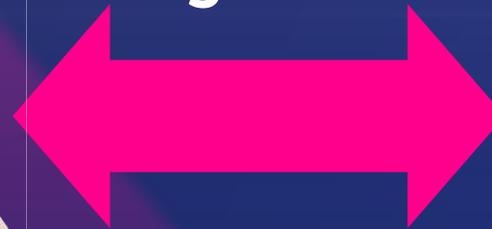


When using AST SpaceMobile

Use AST SpaceMobile satellite signals during natural disasters and other situations where normal network is not available (planned)



Seamless
automatic
migration



Redefining Social Infrastructure through satellite connectivity



Connectivity during disasters

An aerial photograph of a vast archipelago, likely the Japanese Ryukyu Islands, featuring numerous islands of varying sizes, some densely forested and others more rocky. The water is a deep blue, and the sky is clear with light clouds. A white rectangular box is superimposed over the center of the image, containing the text "Connectivity in remote areas" in a bold, white, sans-serif font.

Connectivity in remote areas



Unlock business opportunities

Rakuten SAIKYO SATELLITE Service

Powered by ASTSpaceMobile

Countless possibilities with satellite connection



Communication during natural disasters



Service on remote islands



Lifeline for accidents

Rakuten SAIKYO SATELLITE Service

Powered by ASTSpaceMobile

New IoT business opportunities



Mountainous area disaster prevention,
early detection of disasters



Droned delivery to remote and
mountainous areas



Reduction of wildlife damage,
ecosystem monitoring

*Direct communication services with satellites are now possible for existing NB-IoT devices due to ground eNB support for NB-IoT. Intended to complement the signal from land-based base stations. Images are for illustrative purposes only.

*Aiming to provide strongest satellite service.

Comparison of Assumed Use Cases and Service Specifications

- Under normal conditions, the system provides broadband connectivity to users outside terrestrial coverage areas.
- In emergency (SOS) situations, service restrictions are applied to secure the maximum number of simultaneous connections.

Assumed Use Cases

Use Cases	Images	Target users and services
Normal Operation	 Maritime Areas 	Operators of small vessels (e.g., fishing boats) SMS, Voice calls, Data communications
	 Mountainous / Remote Areas / Isolated Islands 	Hikers residents in out-of-coverage areas SMS, Voice calls, Data communications
Emergency Operation	 SOS 	All Users SMS, Voice calls, Data communication
	 Backup Communication 	All Users Service levels are restricted (e.g., SMS-only) Optimized to maximize the number of supported users

Service Spec

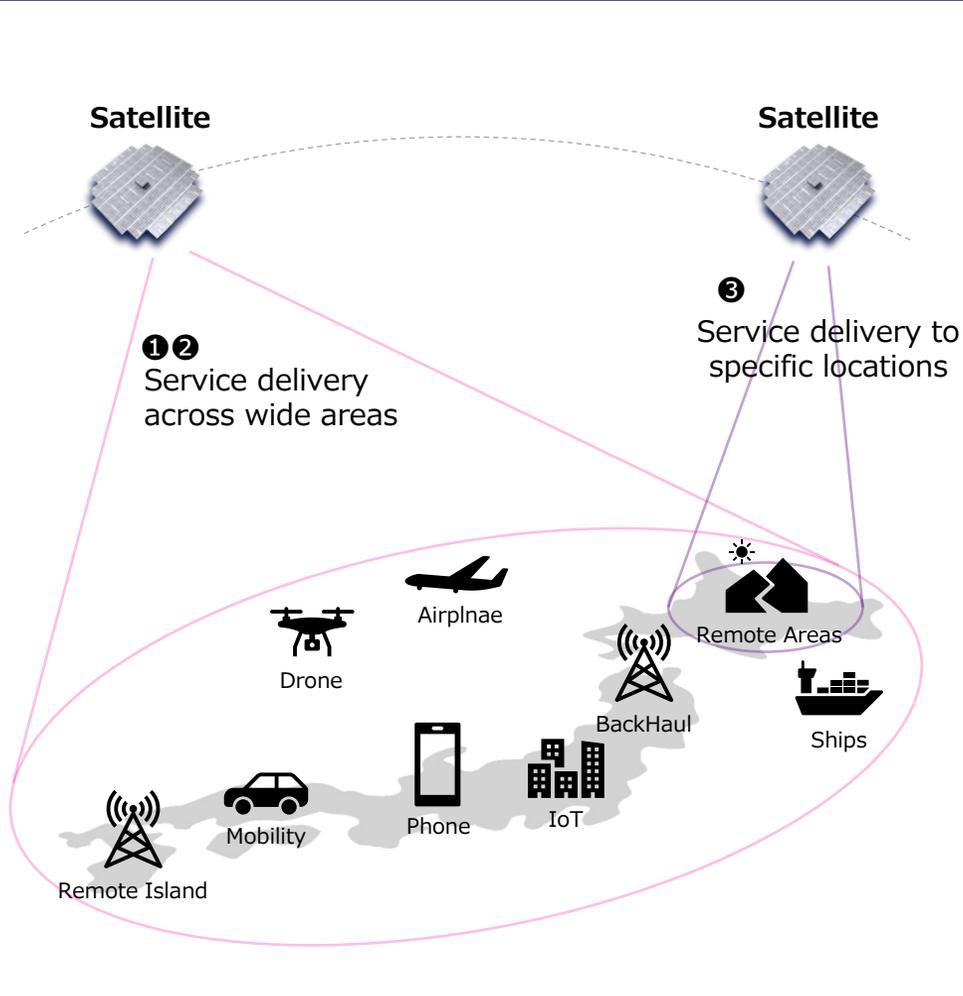
Throughput Requirements

 Video	2~3 Mbps/User
 Voice Call	0.3 Mbps/ User
 Current	0.25 Mbps/ User
Rakuten Link Medium	0.1 Mbps/ User
Low	0.075 Mbps/ User
 E-mail	0.1 Mbps/ User
 SMS	~ 0.1 Mbps/ User

IoT Use Cases Enabled by Satellite Communications

Satellite communications enable a wide range of IoT use cases, including large-area tracking, data collection across wide regions, and message delivery to specific locations.

IoT Concept Using Space Mobile Service



#	Items	Examples
1	Large-Area Tracking	<ul style="list-style-type: none"> ✓ Tracking airborne assets such as drones and aircraft ✓ Tracking vessels in maritime and remote island areas ✓ Tracking people and assets in mountainous regions and forests (e.g., hikers) ✓ Detection of incidents and anomalies in construction, civil engineering, and mining sites ✓ (e.g., accidents, fires, equipment failures)
2	Large-Area Data Collection	<ul style="list-style-type: none"> ✓ Monitoring of ground movement, vibration, sound, waves, fires, temperature, and toxic gases ✓ Prediction, prevention, and early detection of accidents and disasters through data analytics, helping to minimize damage
3	Messaging to Specific Areas	<ul style="list-style-type: none"> ✓ Message delivery to designated areas such as remote islands, mountainous regions, forests, construction sites, large-scale development areas, mining sites, and offshore areas ✓ Disaster alerts and warning messages (e.g., typhoons, tsunamis, earthquakes) ✓ to support damage prevention and mitigation

IoT Ultra-Coverage Use Cases (Ideas)

This proposal examines IoT use cases focused on early situational awareness during disasters as well as day-to-day monitoring and tracking of people and assets.

#	Items	Images	Details
1	Early Situational Awareness During Disasters		<ul style="list-style-type: none">✓ Rapid assessment of disaster-affected areas using fixed cameras and mobile-network-connected drones✓ Enables timely emergency response and supports the planning of appropriate countermeasures
2	IoT Trackers (Personal Safety & Monitoring)		<ul style="list-style-type: none">✓ Improved safety for hikers by renting out trackers at registration✓ Real-time visibility into hikers' locations and routes, helping to reduce congestion and confusion on trails✓ Detection of incidents such as falls or landslides using impact and barometric pressure sensors, and automatic transmission of the hiker's location when necessary
3	Coverage Expansion Using Mobile-Network-Connected Drones		<ul style="list-style-type: none">✓ Maximizing the potential of cellular-connected drones, extending operations beyond urban areas to mountainous and remote regions
4	Infrastructure Monitoring / Smart Metering		<ul style="list-style-type: none">✓ Digital transformation (DX) of infrastructure meters located in remote or hard-to-access facilities✓ Monitoring of lifestyle-related infrastructure in mountainous areas✓ Monitoring of water volume, temperature, and water quality at hot springs and water supply facilities

NTN Use cases, Architecture and Standardization Evolution

Characteristics of Satellite Communications

	LEO	MEO	GEO
Altitude	160–2,000 km	2,000–36,000 km	36000 km (Equator)
Satellite Constellation	Thousands of satellites	Dozen(s)	3 satellites for global coverage
RTT	28 – 60 ms	120 – 200 ms	500 – 700 ms
Beam footprint	50 – 1000 km	100 – 1000 km	200 – 3500 km
Coverage	Global, including polar regions	Near-global	Global, except Polar regions
Use Cases	Internet / high thruput, near real time comm, IoT	Navigation (GPS), High throughput data	Broadcast TV, Weather Monitoring
Benefits	Low Latency, High throughput	Balanced Latency, fewer satellites	Wide, contiguous coverage from a fixed point
Drawbacks	High Network Complexity, frequent handoffs	Higher latency than LEOs	High Latency, poor for high speed data

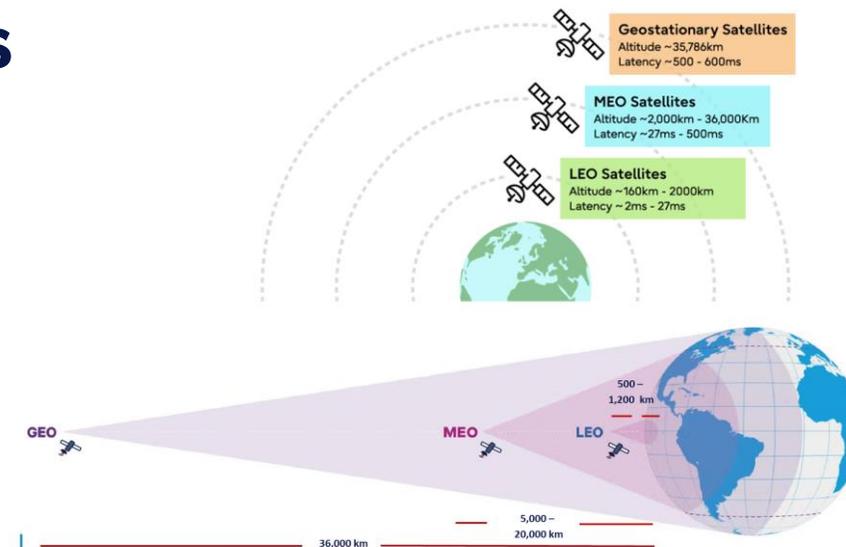


Figure 1: Schematic of orbital altitudes and coverage areas

High Doppler Shifts

- Due to High relative speeds
- LEO speeds: 28,000 km/h
- UE: 0, 30km/h (auto) 900 km/h (airplanes)
- Up to **25ppm** (50kHz @ 2GHz carrier freq)

High RTT, Differential Delay

- Caused by large distances between UEs and Satellites
- **LEO:** 500 – 2K km, **RTT= 28 – 60 ms**
- **MEO:** 2K – 36K km, **RTT= 120 – 200 ms**
- **GEO:** 36K km, **RTT= 500 – 700 ms**

Evolution of NTN technology and standardisation

Initial NTN study

- Key reports: TR 38.811, TR 38.821
- Challenges analysed: long RTT, Doppler, mobility
- Foundation for Rel-17 specifications

Coverage and uplink performance enhancements

- Mobility and service continuity improvements
- Enhancements for IoT-NTN deployments
- Integration into broader 5G-Advanced feature set

Advanced NTN integration

- GNSS-independent and resilient operation studies
- Enhanced mobility between TN and NTN
- Harmonized 6G Radio design for TN and NTN towards ubiquitous connectivity

Rel-16

Rel-17

Rel-18

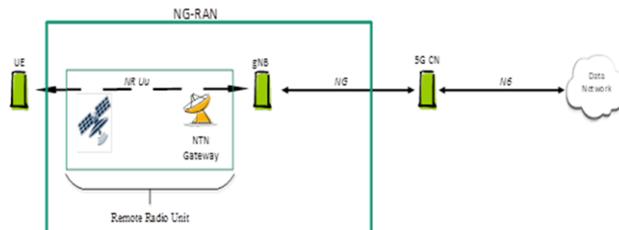
Rel-19

Rel-20



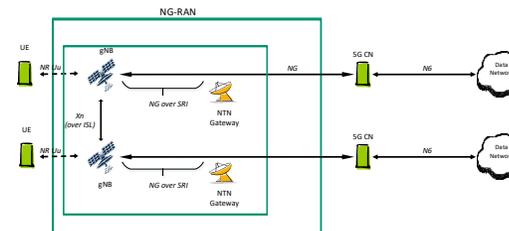
First normative NR-NTN support

- Transparent (bent-pipe) satellite payload focus
- Support for NR eMBB and NB-IoT / eMTC over NTN
- Defined NTN frequency bands (e.g. n255, n256)



Support for regenerative satellite payloads

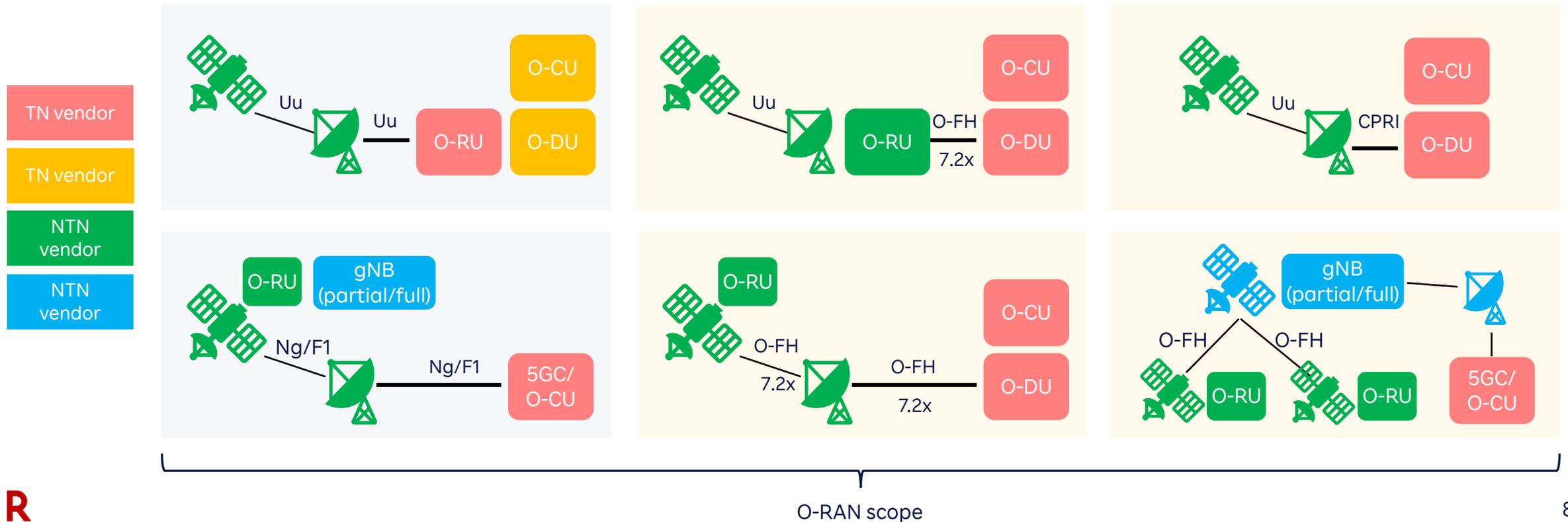
- On-board gNB functions and routing capabilities
- Inter-satellite links (ISL) support
- Capacity, multicast, and IoT NTN enhancements



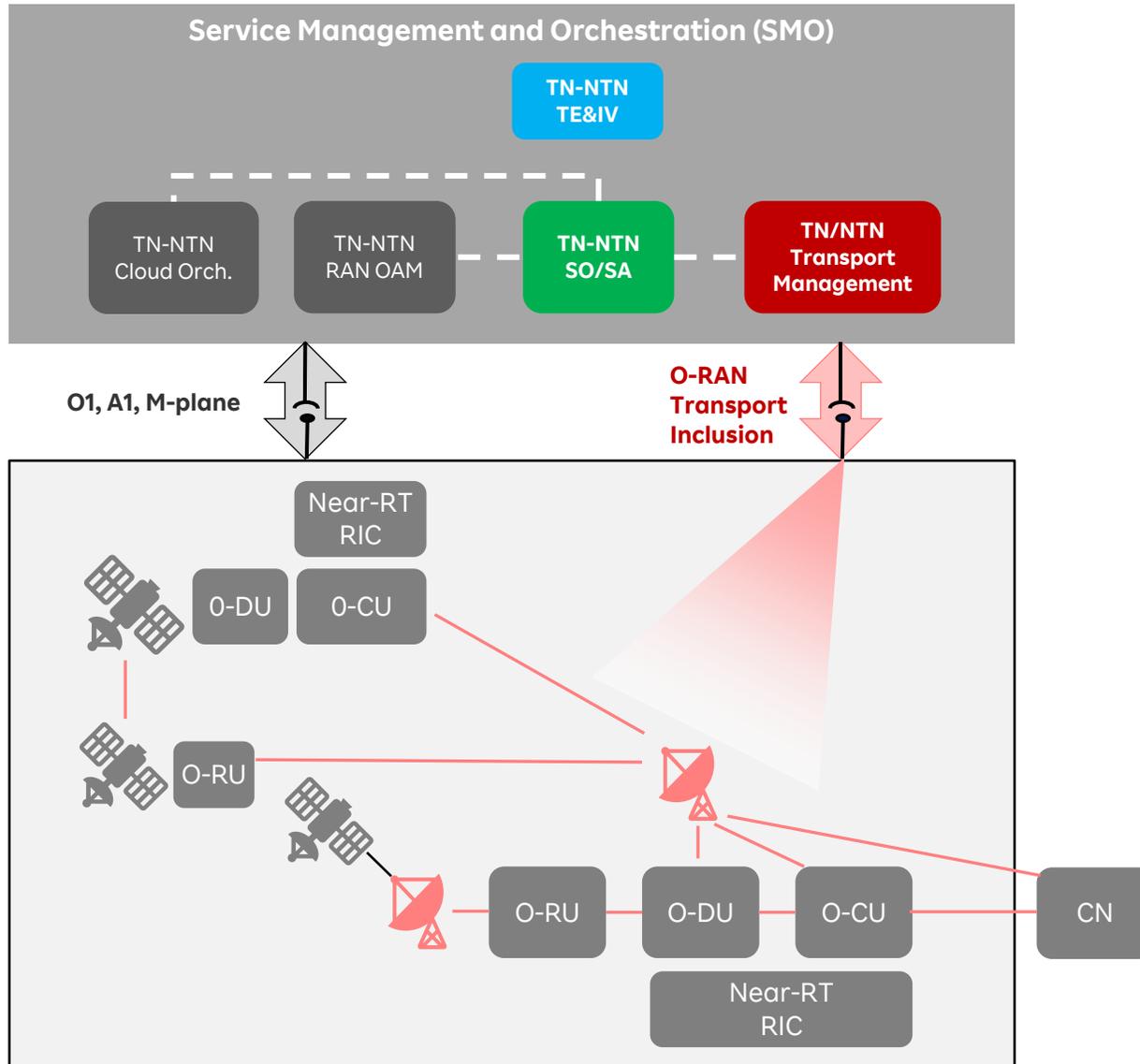
O-RAN's Responsibility and Opportunities

Multi-Vendor Interoperability

- 3GPP only specifies for payload scenario and split options for system elements within 3GPP scope and focusing on enabling the Uu service over satellite.
 - **O-RU and fronthaul interface is outside the scope of 3GPP**
 - **Interoperability between TN and NTN vendors is not the focus.**
- There are wide variety of industry solutions and multi-vendor interoperability scenarios existing today.

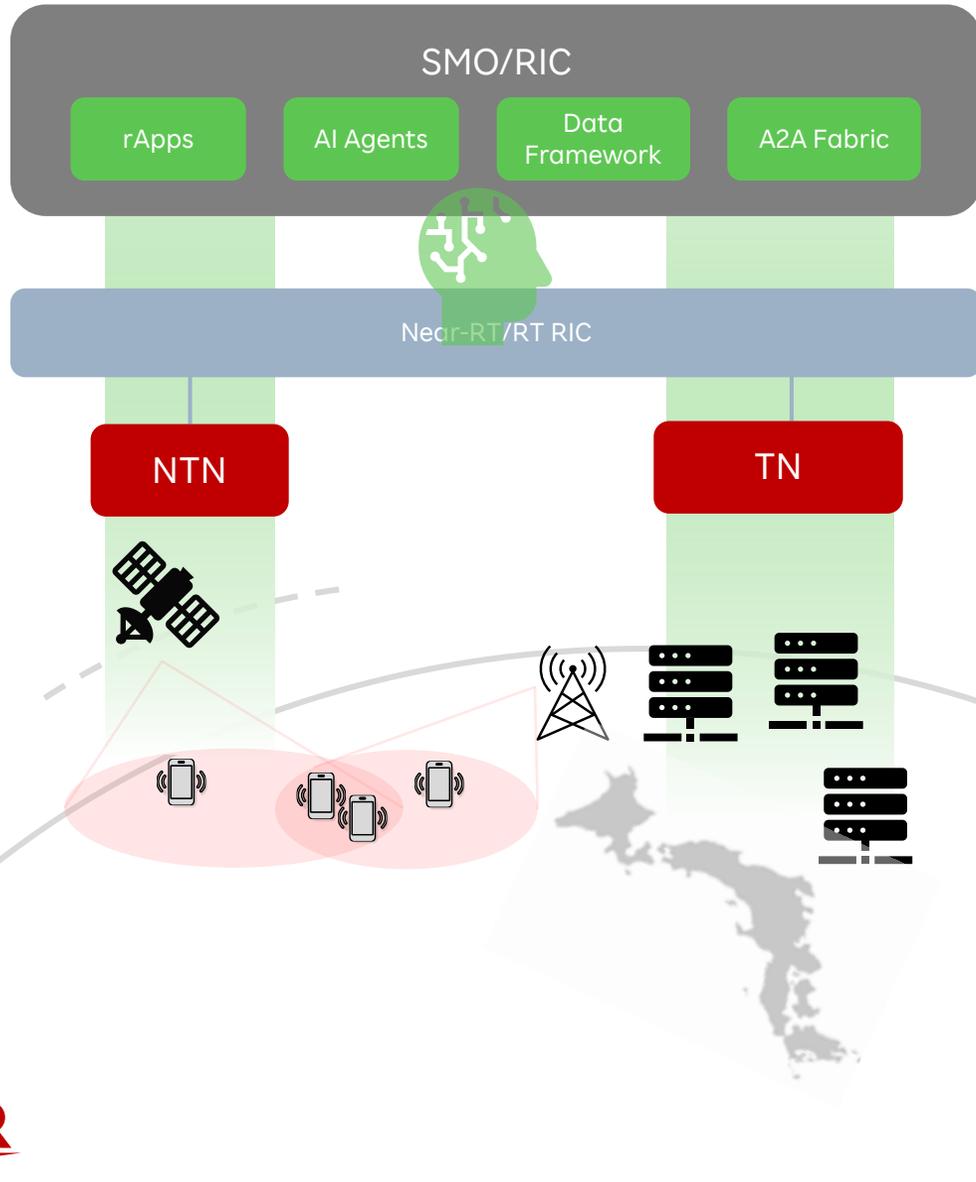


E2E Service Orchestration, Assurance with Transport Inclusion



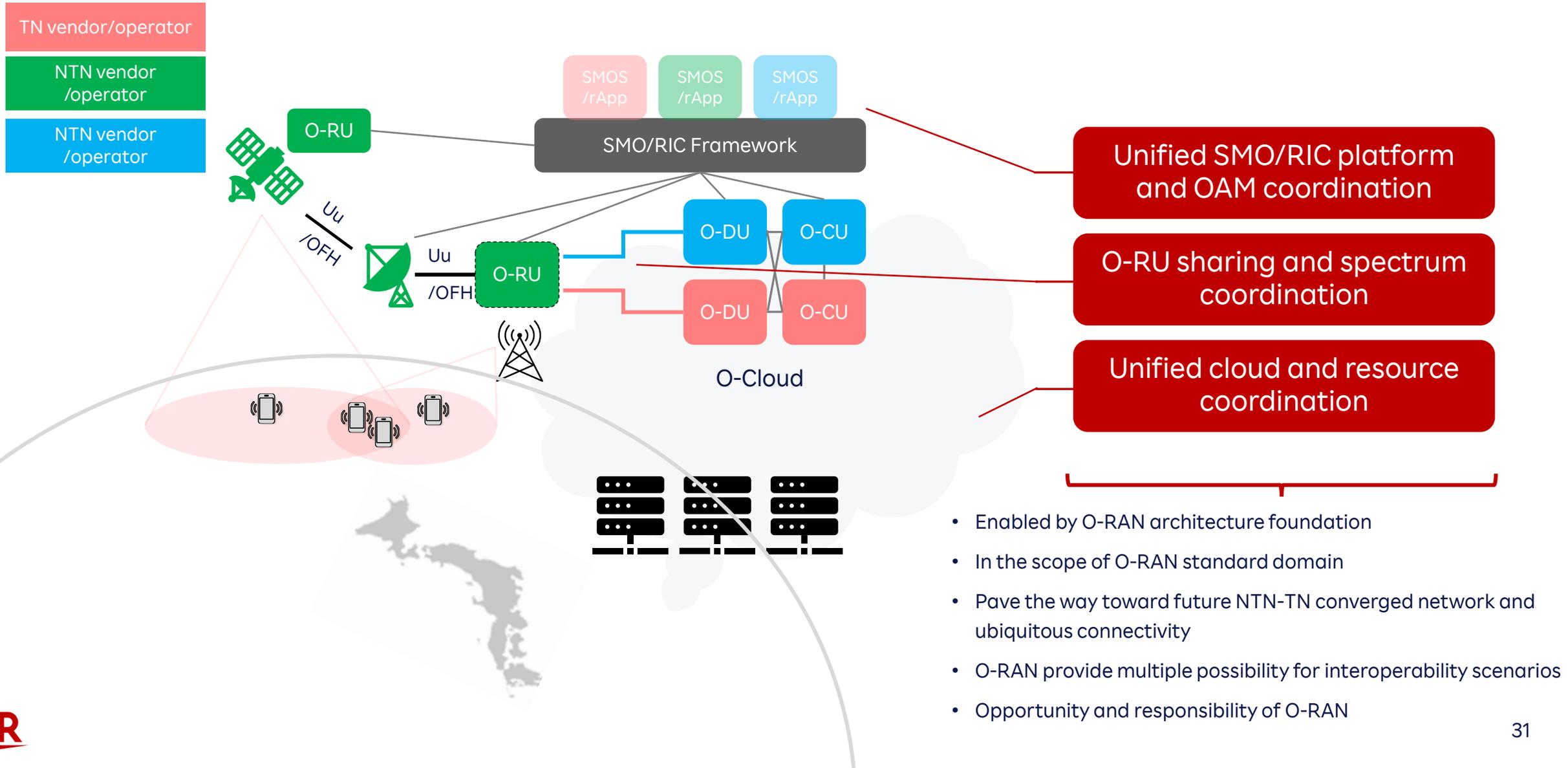
- ❑ E2E NTN and TN service orchestration and assurance towards full automation and zero touch for complicated converged TN-NTN network.
- ❑ Wireless unideal NTN transport becomes key factors affecting E2E KPIs and user experience. Full automation and SLA assurance for NTN feeder link and ISL transport becomes critical.
- ❑ NTN transport failure recovery
 - Feeder link congested
 - Failed or congested ISL
 - Failed satellite
- ❑ Feeder link and ISL switching management.
- ❑ NTN Inventory management
- ❑ Ongoing O-RAN decoupled SMO and transport inclusion works lay great foundation for comprehensive NTN-TN converged RAN in 6G.

RIC and Agent Driven NTN-TN Optimisation

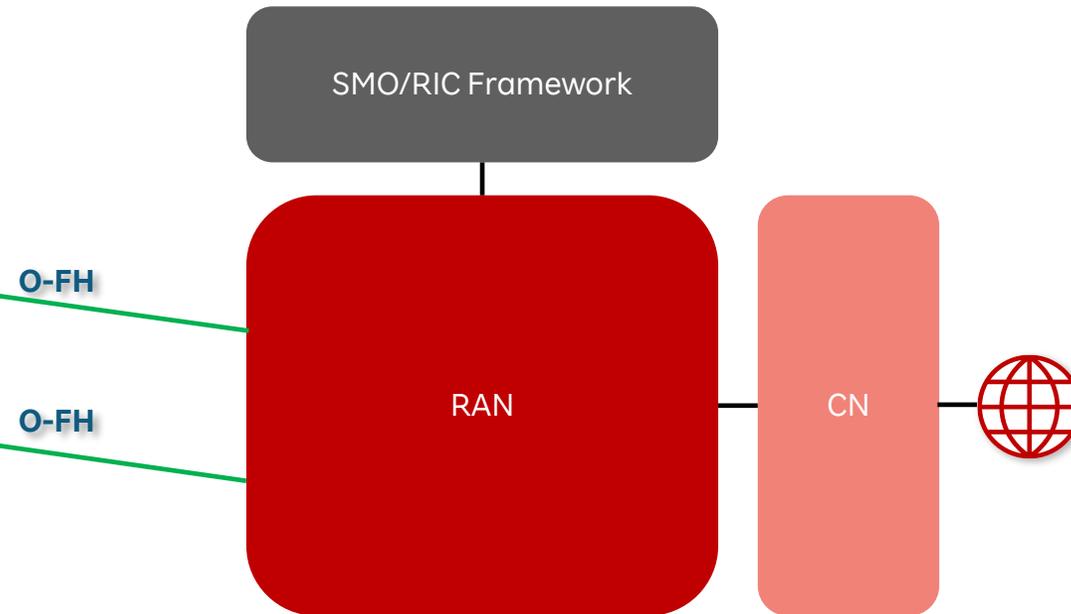
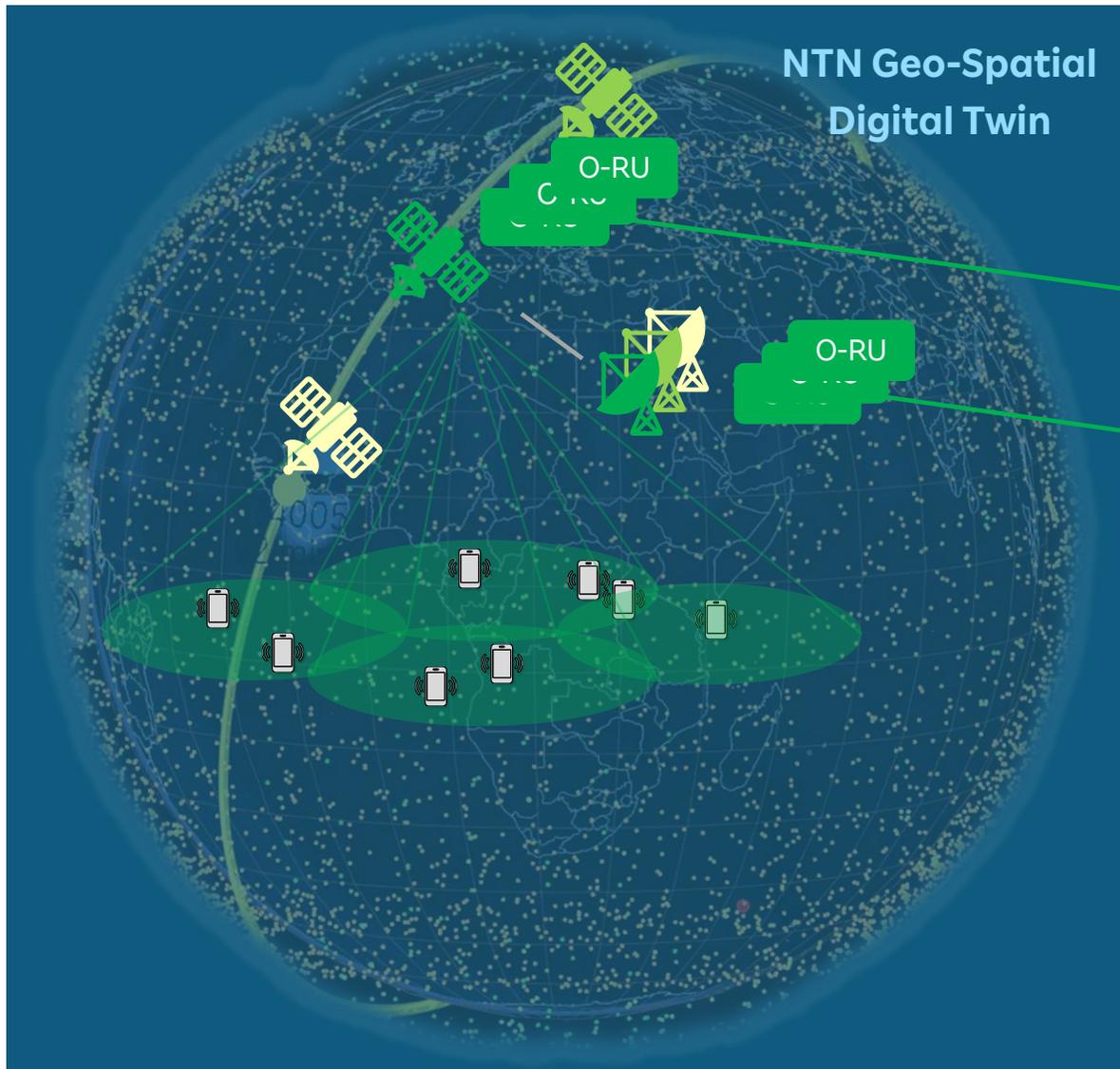


- NTN-TN spectrum sharing, radio resource allocation
- Load balancing, traffic steering between NTN and TN
- NTN-TN mobility HO optimization
- Coverage and interference management
- NTN beam and cell management
- UE geo-location estimation, satellite and UE trajectory prediction
- Cross RAN layer optimisation
- QoE aware and satellite ephemeris aware optimisation
- Policy driven and intent driven optimisation
- Anomaly detection and RAN analytic

NTN and TN Operator/ Vendor Integration and Interworking



NTN Digital Twin



Scaled lab NTN testing with NTN digital twin

Predict and validate real system KPIs before service launching

Load	QoS	Coverage	Cell Switching
Link failures		Load balancing	Interworking

Thanks