

ITU Workshop

Quality of Service (QoS) and Quality of Experience (QoE)
Aspects of Satellite-based Internet Services

In-field performance testing of Non-Terrestrial Networks

June 2026



Arnd Sibila
Technology & Market Development Manager

ROHDE & SCHWARZ

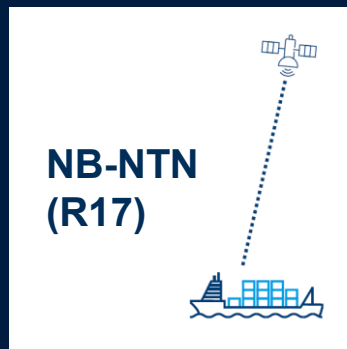
Make ideas real



NTN modes

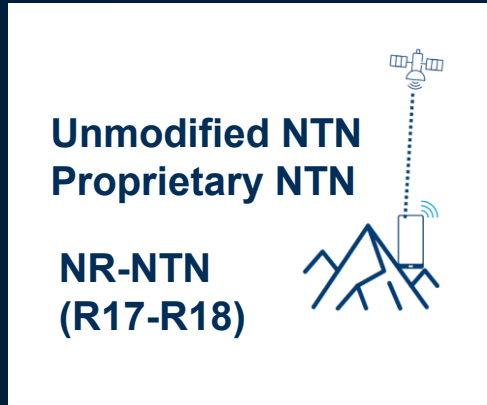
► IoT services offered by a Satellite market player

- Solution: **NB-NTN (IoT-NTN)**
 - Based on NB-IoT with R17 enhancements for IoT over Satellite
 - Example GEO satellites: Skylo, Viasat
 - Example LEO satellites: Iridium

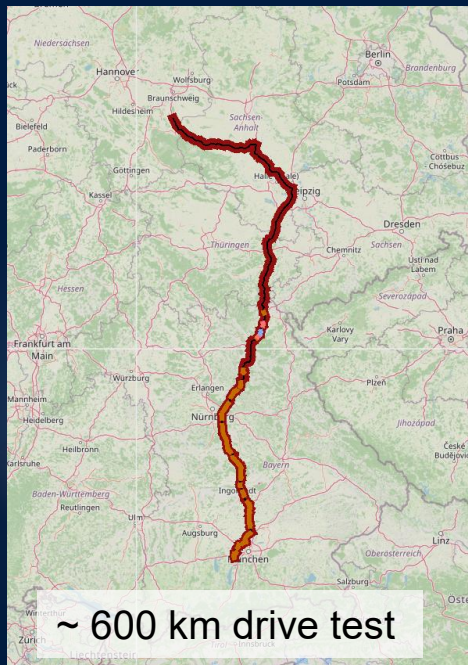


► Mobile services offered by a NTN market player

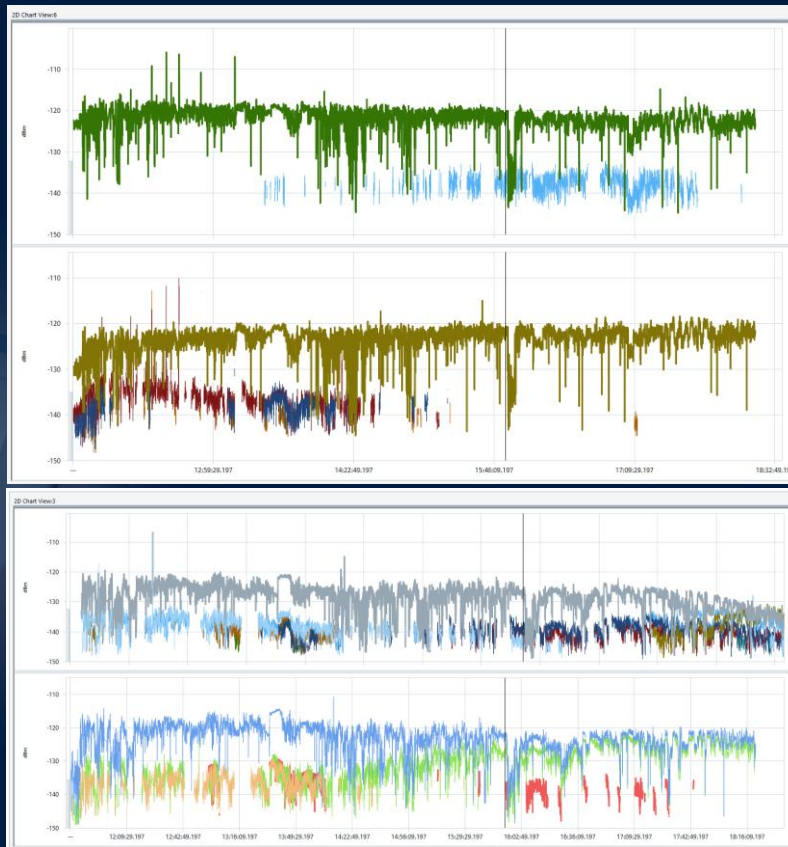
- **Unmodified NTN** (Standard LTE signals; **available**)
 - Work with legacy UEs in the market today
 - Examples LEO: StarLink Direct-to-Cell, AST SpaceMobile, ...
- **Proprietary NTN (available)**
 - Work with specific UEs and special link protocols
 - Example LEO: Globalstar Emergency SOS service for iPhone 14+
- **NR-NTN (later → 2027?)**



GEO satellite NB-NTN scanner measurements



Huge GEO cells: even over this long distance, a single PCI is dominant!



NTN LEO – Technical challenges and what to measure passively?

► Coverage / Propagation loss – it's a long way!

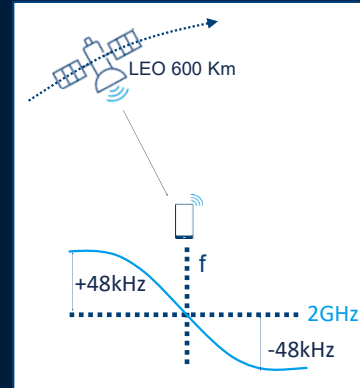
- Cell Reference Signal Measurements in Downlink (RSRP, RS-SINR, RSRQ)

► Doppler shift – LEOs are fast!

- The “base station” (satellite) is moving with 8km/s !
- Satellite link pre-compensates the Doppler shift (D2C – Direct-to-Cell)

► Spectrum Utilization

- Monitoring of cross-border scenarios (regulatory tasks)
- Expected NTN Channels vs Interfering NTN Channels from neighbor countries/regions



► Passive testing with network scanner



NTN – Technical challenges and what to measure actively?

- ▶ Coverage / Propagation loss
 - Cell Reference Signal Measurements in Downlink (RSRP, RS-SINR, RSRQ)
 - How to reach the satellite in **Uplink** direction? RACH: Success Rate and Response time
- ▶ Cell Movement
 - Tracking Area Update and **Handover**: Success Rate and Interval
- ▶ Larger Delays: Interactivity Testing (according to ITU-T G.1051)
 - Round-trip Latency, Packet Loss, Packet Delay Variation, (also direction-specific)
- ▶ Application testing: Messaging and Data Transfer (acc. to ETSI TR 103 559 test method)
 - SMS Testing: Success Rate, Send Duration, E2E Delivery Time
 - Data Transfer Testing
 - All suitable Apps
- ▶ Forcing test phones to satellite signals: LTE, frequency band

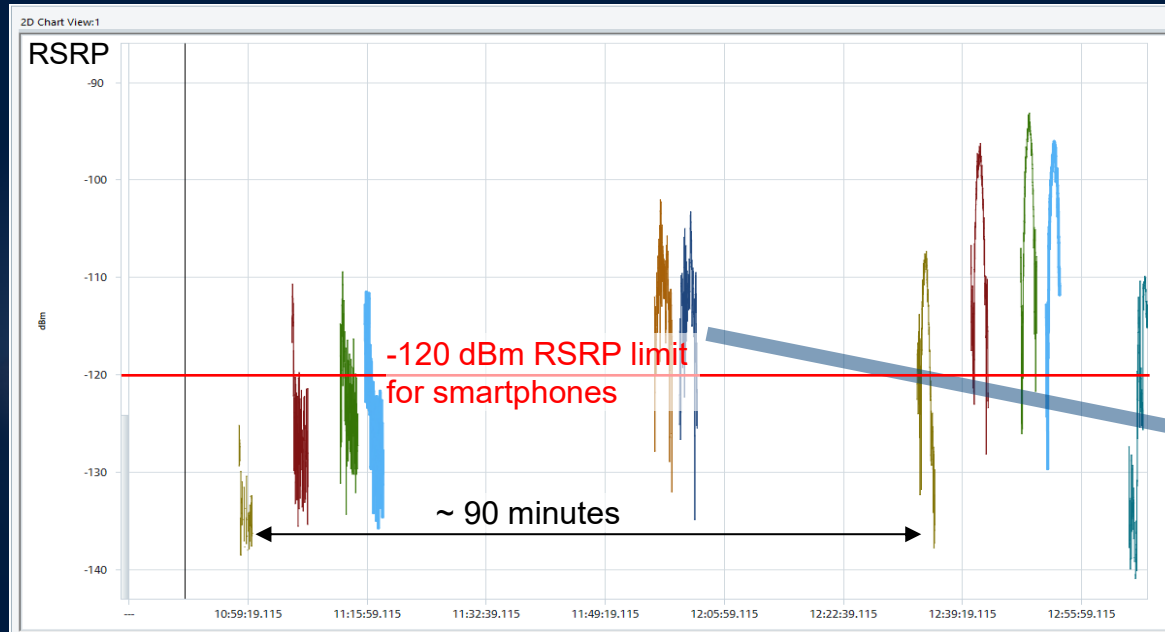
▶ Active testing with a smartphone (QualiPoc Android SW)



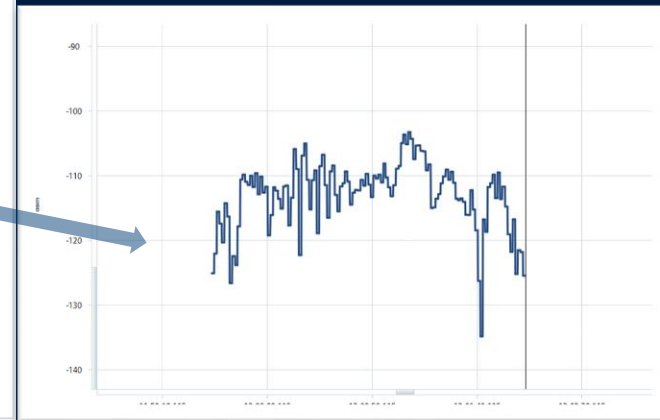
Example: Scanner measurement of LEO NTN LTE signal



- Coverage measurements of a LEO satellite network transmitting a standard LTE signal



Status End of 2023
(Seattle / WA)

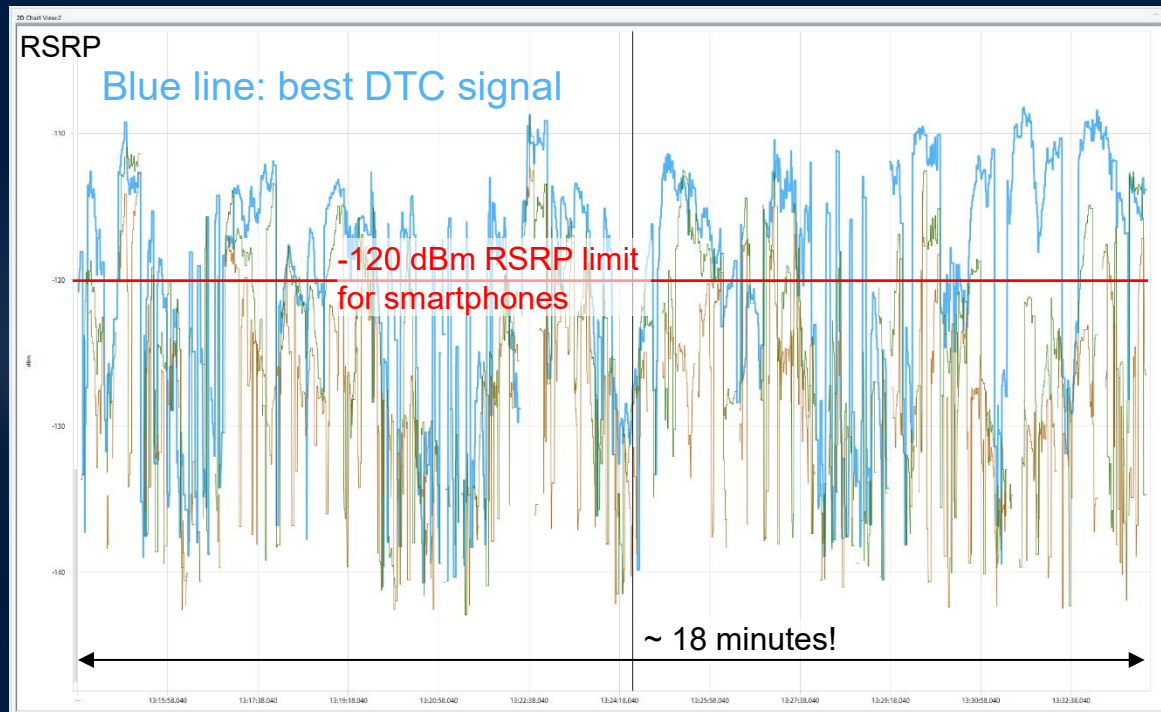


Satellite visible for 2min 30sec

Example: Scanner measurement of LEO NTN LTE signal



- Coverage measurements of a LEO satellite network transmitting a standard LTE signal



Status April 2025 (Montana / US)

- > 100 LEO signals/beams received (could not be visualized)
- Best 3 DTC signals visible (always different satellite beams)
- PCIs are reused and change quickly (max 504 in LTE)

- On the path to ubiquitous coverage

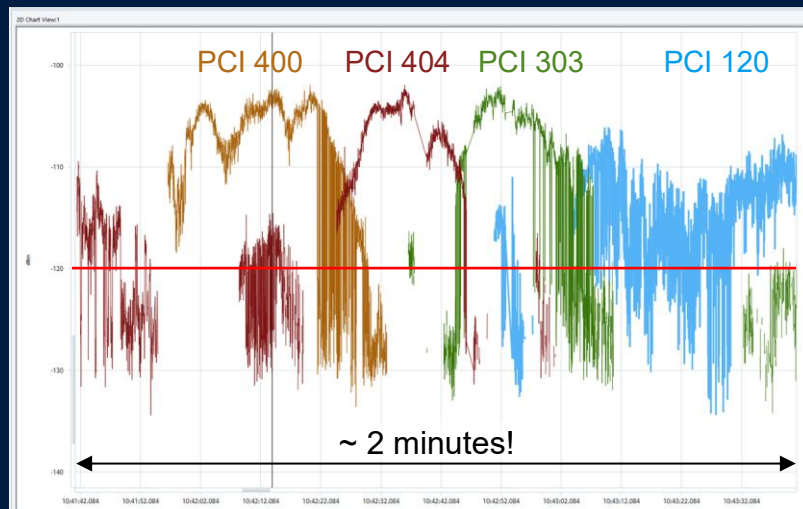
LEO NTN DTC LTE – different approaches to cover the Earth

- ▶ Starlink: PCI changing frequently on Earth

+	eNodeB - ID:11371/42 PCI:446
+	eNodeB - ID:11400/59 PCI:52
+	eNodeB - ID:11469/112 PCI:303
+	eNodeB - ID:11469/126 PCI:120
+	eNodeB - ID:11469/128 PCI:404
+	eNodeB - ID:11469/189 PCI:400
+	eNodeB - ID:11490/1 PCI:172
+	eNodeB - ID:11490/146 PCI:101

eNodeB-ID identifies the Starlink satellite

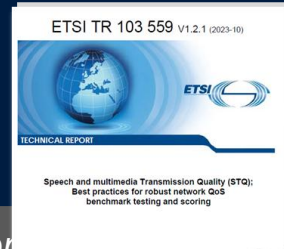
Satellite visible for 2 min with 4 PCIs (satellite beams)



- ▶ AST SpaceMobile: try to keep PCI on Earth constant (PCI handover from satellite to satellite)
→ measurements to be done

Performance score R&S ETSI TR 103559 test method

Score covers all use case classes



P2P direct real-time connection

Telephony (3GPP)

- 2G/3G Call
- VoLTE Call
- VoNR Call

Focus on mobile-to-mobile

Telephony VoIP (OTT)

- WhatsApp (VoIP)
- Signal (VoIP)
- MS Teams (VoIP)
- BiP (VoIP)
- MCX (PTT)

Video Conferencing

- MS Teams video sharing
- WhatsApp video call

Receiving / sending media w/ motion, real-time

Streaming media

- UDP Stream uplink
- UDP Stream downlink

Interactive media

- Interactivity (ITU G.1051)

Streaming media

- YouTube live video
- YouTube 4K
- Instagram Reels
- Facebook Reels
- TikTok video
- Video uplink

Interactive media

- VR Interaction

Up- or download files

File transfer

- HTTP file transfer
- FTP file
- SMS/RCS messaging

Messaging

- WhatsApp messaging
- Signal messaging
- MS Teams Chat

Social media

- Browsing
- Facebook Posting
- Instagram Posting
- Twitter Posting

Content Transport performance

Data speed

- HTTP/TCP Capacity
- UDP Capacity
- FTP Capacity
- IPERF

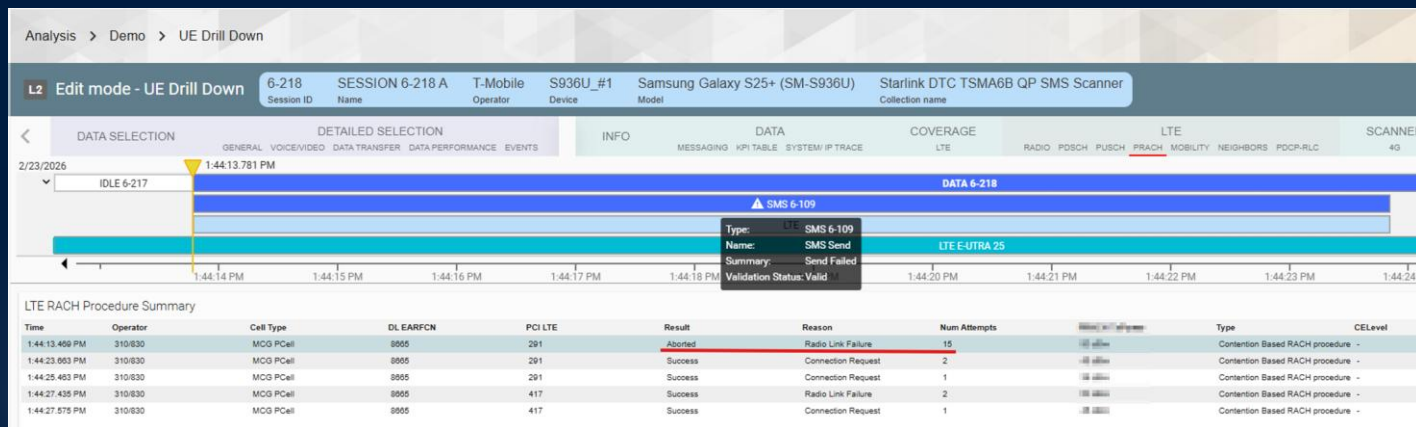
Latency

- UDP stream RTT latency
- Ping / Trace Route

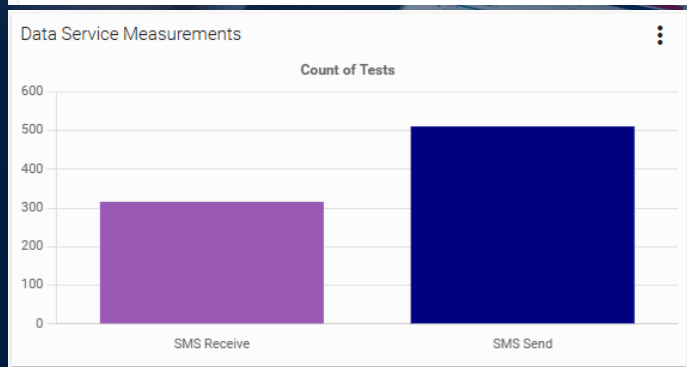
Speed test Apps

- Ookla speed test
- xyz speed test

Example: Active measurements of LEO NTN LTE signal with QualiPoc Android



Status Feb. 2026
(Irvine, CA)



- ▶ Sending SMS in UL creates failures
- ▶ SMS success rate much worse compared to terrestrial networks *)
- ▶ As expected: UL is the bigger problem

*) Disclaimer: test phone may not have installed a "special SW patch"

Network Scanner capabilities

Sensitivity:

- ▶ DTC LTE Signals can be detected (PCI, ARFCN, physical parameters) at
 - RSRP above -147 dBm (25 dB better than a Smartphone)
 - RS-SINR above -20 dB
- ▶ DTC LTE Signals can be decoded (MCC / MNC, PLMN-ID, eNodeB-ID) at
 - RSRP above -130.5 dBm
 - RS-SINR above -1.5 dB

Discussions in CEPT ECC groups ongoing about

- PFD measurements
- NTN- and TN-Signal identification
- Interference consideration



CMX500: Universal NTN Device Testing Platform (in the lab)

- ▶ **Unified Technology Support:** A single unit for NR-NTN, NB-NTN, and Direct-to-Cell (DTC/D2C)
- ▶ **Spectrum & Orbit Versatility:** Full band support (L, S, Ku, and Ka) across multi-orbit scenarios including LEO, MEO, GEO, and GSO
- ▶ **Flexible Architecture:** Advanced emulation of both Transparent and Regenerative payloads
- ▶ **Callbox Integration:** RF measurements, Pre-Conformance Testing, Visualization of Satellite Network
- ▶ **Auto-deployment & Auto-handover:** Automates satellite cells moving in and out of visibility (seamlessly transferring connections)



App-Layer Evaluation

- E2E validation of
 - 20 Gbps IP throughput
 - POLQA speech quality (IMS & OTT based)
 - critical delay measurements

3GPP Conformance

- Industry-leading Rel. 17/18 validated test cases across RF, RRM, and Protocol Conformance layers

Constellation Insight Tool

- Import TLE data to
 - visualize and prepare satellite constellations
 - providing a clear visualization of their corresponding fading data

SUMMARY

NTN LEO constellations are fast-moving Radio Access Networks (RAN)

Unmodified NTN (DTC LTE signals) can be tested in field already now.
NR-NTN constellations are announced for 2027f

Passive and active field measurements evaluate the NTN performance

Standardized test methods for QoE and technical KPIs (such as ETSI TR 103559) are also applicable for NTN DTC field testing (depending on the supported applications)

► **Rohde & Schwarz is your partner for NTN field and lab measurements**

