

Mobile Network Testing

Challenges and Measurements in terrestrial and non-terrestrial networks



Arnd Sibila
Technology Marketing Manager
Mobile Network Testing

ROHDE & SCHWARZ

Make ideas real

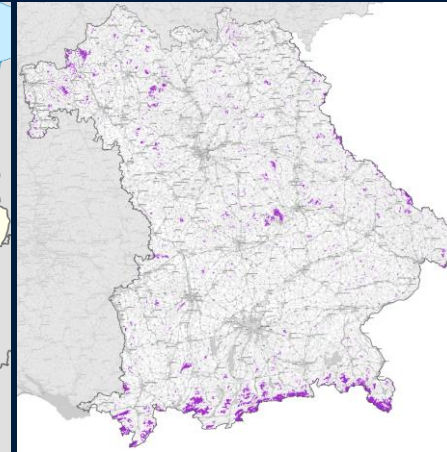


White spots of Mobile Communication (status Jan. 2024)

We immediately think about oceans, deserts and outlands.
Example: Bavaria in Germany

► Are there white spots in Bavaria?

- Only 2G / GSM: **3.56%** of area
- Coverage hole: **0.57%** of area
- Grey spots (only 1 operator): **17.57%** of area



Source: BNetzA (Gigabit-Grundbuch)

► You cannot “measure” the coverage of a 100% area

- Typical benchmarking campaigns cover 25% of the population area (QoE comparison)
- Using drive and walk tests or even “fly” tests
- Even Crowdsourcing data is only available where people are.

What about 5G / LTE license obligations (status Nov. 2022)

Example: Bavaria in Germany

- ▶ 100 Mbps on federal streets and regional train tracks? LTE+5G measurements in Nov. 2022

Bavaria	Federal streets > 100 Mbps	Federal streets < 100 Mbps	Train tracks > 100 Mbps	Train tracks < 100 Mbps
Operator 1	81.9 %	18.1 %	78.5 %	21.5 %
Operator 2	90.0 %	10.0 %	89.6 %	10.4 %
Operator 3	89.4 %	10.6 %	81.9 %	18.1 %

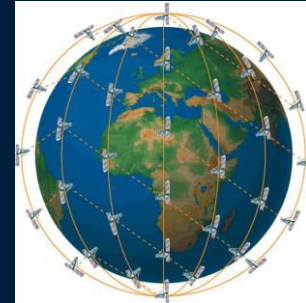
https://www.stmwi.bayern.de/fileadmin/user_upload/stmwi/Foerderungen/Mobilfunkinitiative/Abschlussbericht_Mobilfunk-Messungen_Bayern_2022_StMWi.pdf

- ▶ You can “measure” the coverage and performance of a defined area!
 - Typical benchmarking campaign using a standardized test method (ETSI TR 103 559)
 - Passive tests using network scanners
 - Active tests using smartphone-based test solution → Network Performance Score acc. to ETSI

To close coverage holes - Non-Terrestrial Networks (NTN)

- ▶ Mobile communication via satellites to close white spots of terrestrial networks

Type of satellite Typical dimensions	Altitude range	Typical beam footprint
LEO (Low-Earth Orbit)	300 – 1500 km	100 – 1000 km
MEO (Medium-Earth Orbit)	7000 – 25000 km	100 – 1000 km
GEO (Geostationary Earth Orbit)	35 786 km	200 – 3500 km



Constellation of multiple LEO satellites (some 100 to several 1000) to create a 'net' around Earth.

- ▶ LEO#1 in 1000 km altitude takes ~ 90 minutes to circle Earth
 - Beam footprint: LEO#1 visible for 1-2 min every 90 minutes (fixed beams, longer for steerable beams) → LEO network
- ▶ Direct-to-Cell (DTC) uses terrestrial spectrum that is allocated per country! What about borders?

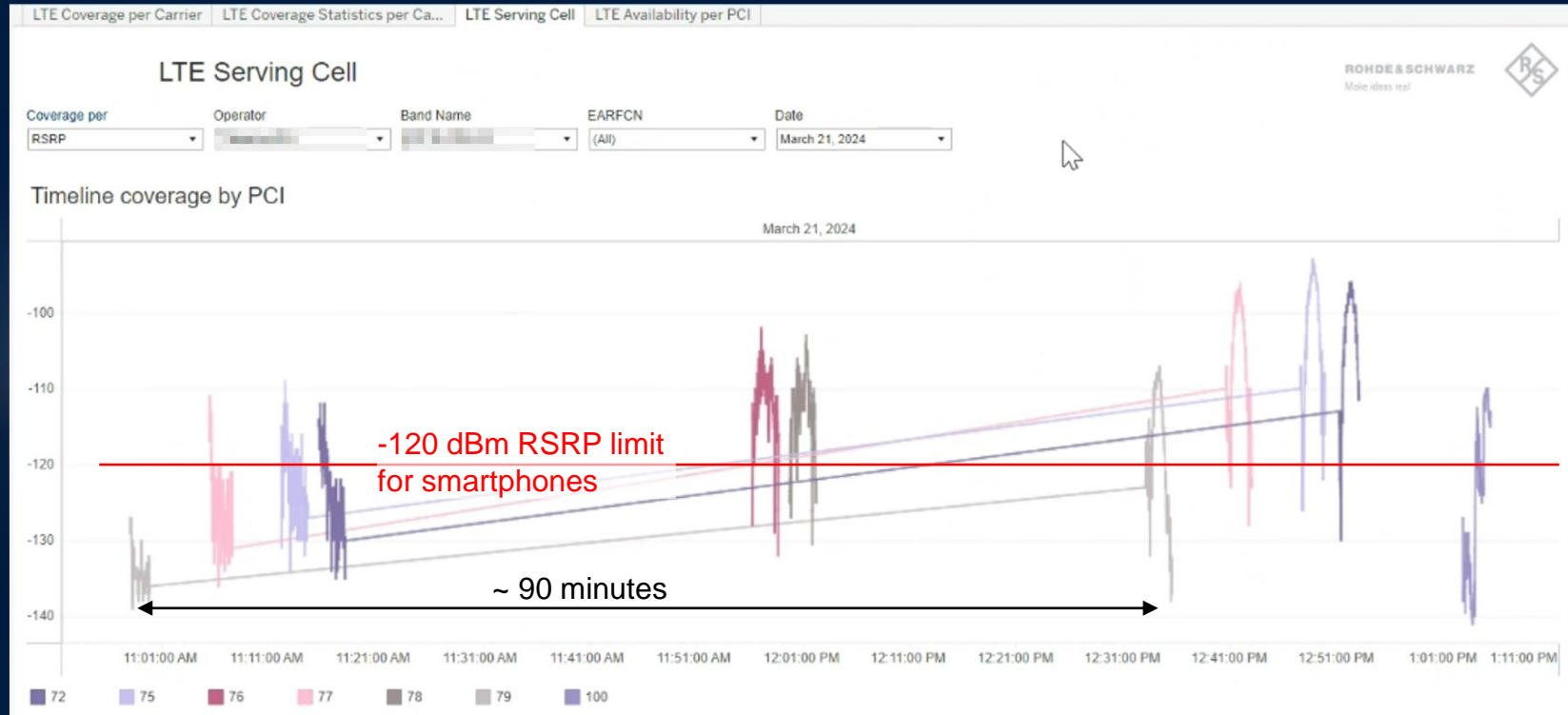
Example - FCC SCS - Supplemental Coverage from Space

- ▶ **SCS operator must have a spectrum lease arrangement (from terrestrial licensee(s))**
- ▶ **SCS Bands - Implemented as bi-directional, secondary MSS (Mobile Satellite Service)**
 - 600 MHz: 614 - 652 MHz and 663 - 698 MHz
 - 700 MHz: 698 - 769 MHz, 775 - 799 MHz, and 805 - 806 MHz
 - 800 MHz: 824 - 849 MHz and 869 - 894 MHz
 - Broadband PCS: 1850 - 1915 MHz and 1930 - 1995 MHz
 - AWS-H Block: 1915 - 1920 MHz and 1995 - 2000 MHz
- ▶ **Power flux-density and in-band field strength**
 - 40 dB μ V/m for the 600 MHz, 700 MHz, and 800 MHz bands
 - 47 dB μ V/m for the AWS and PCS bands
 - aggregate field strength (earth's surface) by all visible beams and satellites providing service
- ▶ **Certification of terrestrial devices: license by rule!**
- ▶ the terrestrial licensee's license parameters apply
- ▶ **Interim 911 text and call routing requirements**
 - Dedicated/appropriate SCS PSAP

Example: Coverage measurement of NTN LTE signal



- ▶ Scanner measurements of a LEO satellite network transmitting a standard LTE signal



NTN – Technical challenges and what to measure passively?

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

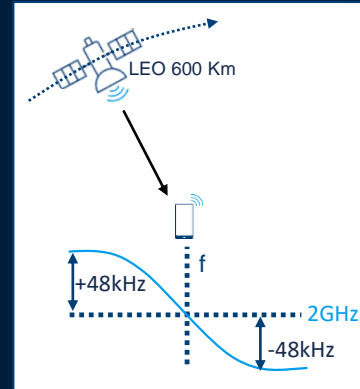
- Cell Reference Signal Measurements in Downlink (RSRP, RS-SINR, RSRQ)

▶ Doppler shift – LEOs are fast!

- In terrestrial networks: smartphone is moving in a car or train
- Here, the “base station” (satellite) is moving with 8km per second!

▶ Spectrum Utilization – Case: Unmodified NTN with leased spectrum

- Monitoring of NTN Band blocks
- 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?
 - Random Access (RACH): Success Rate and Response time
 - NB-NTN: Coverage enhancement repetitions (CE level)
- ▶ Cell Movement
 - Tracking Area Update: Success Rate and Interval
- ▶ Large Delays
 - Interactivity Testing: Round-trip Latency, Packet Loss, Packet Delay Variation, (also One-Way)
- ▶ Application testing: Messaging and Data Transfer (acc. to ETSI TR 103 559 test method)
 - SMS Testing: Success Rate, Send Duration, E2E Delivery Time
 - Small Data Transfer Testing (NB-NTN)

▶ Passive testing with a smartphone (QualiPoc Android SW)



Regulatory challenges / questions

- ▶ Many technical topics (KPIs) can be measured with passive and active testing solutions already now.
- ▶ But what about regulatory questions?

Examples:

- ▶ Spectrum Utilization in Direct-to-cell mode:
 - What will the regulators require to measure?
- ▶ Monitoring of NTN Band blocks:
 - What happens at country borders?
- ▶ Roaming issues:
 - various satellite constellations, various operator cooperations, various SIM/eSIM in unmodified devices, what interworks?

Thank you! www.rohde-schwarz.com/mnt