Mobile Network Testing
Standalone and system test solutions

- 15 May 2018

- Zoran Asenov
- Netra Ltd. (R&S partner)
- zoran@netra.com.mk

The R&S company group at a glance

- **History**
  - Established 1933 in Munich, Germany
- **Type of enterprise**
  - Independent family-owned company founded by Lothar Rohde and Hermann Schwarz
- **Global presence**
  - In over 70 countries, approx. 60 subsidiaries
- **Export share 85 %**
- **Employees**
  - 10000 worldwide, with approx. 6000 in Germany

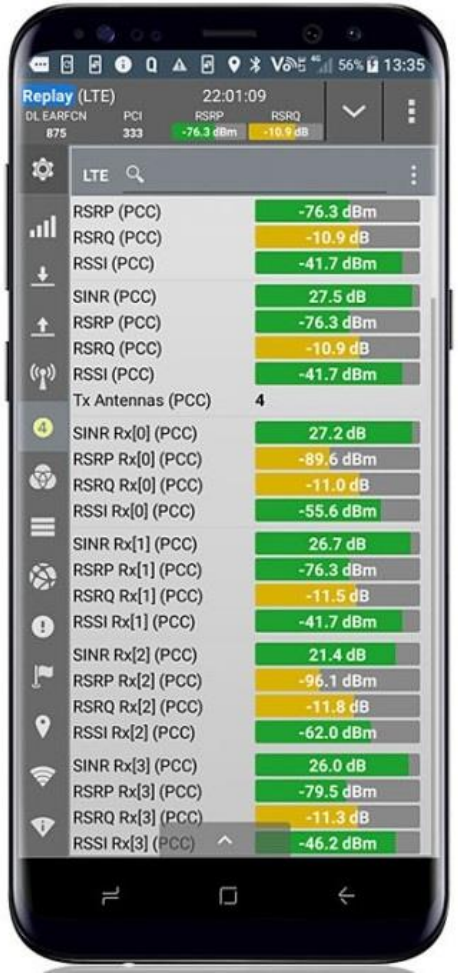
R&S Business fields

Test and Measurement	Broadcast & Media	Secure Communications	Cybersecurity	Monitoring and Network Testing
T&M instruments and systems for: • Wireless communications • General purpose electronics • Aerospace & defense applications	Broadcast, T&M and studio equipment for: • Network operators • Broadcasters • Studios • Film industry • Manufacturers of entertainment equipment	Communications systems for: • Air Traffic Control • Armed forces. Encryption technology for: • Armed forces • Government authorities • Critical infrastructures	IT security products for: • Economy • Authorities	Radio monitoring equipment for: • Regulatory authorities • Homeland and external security Network Testing • Network operators • Infrastructure Vendors • Service Companies • Regulators
Service				

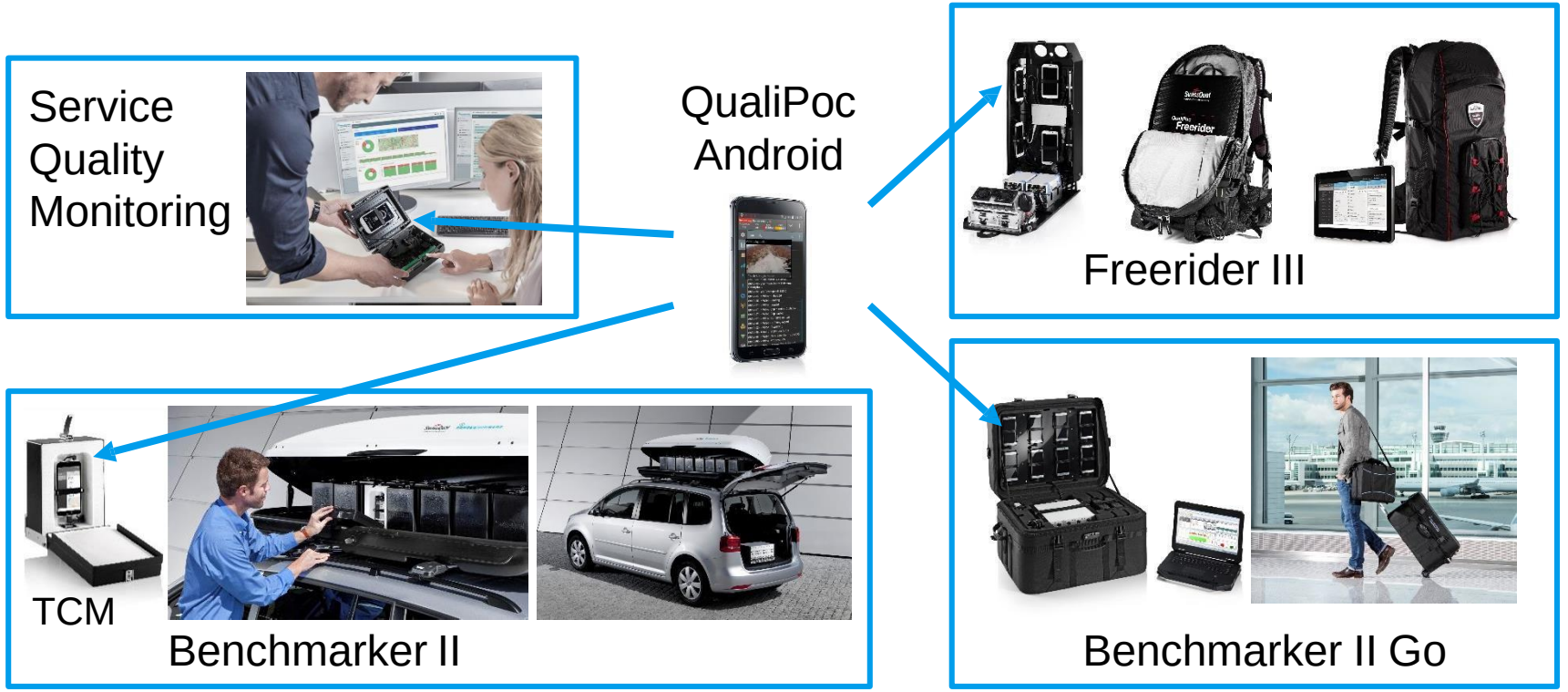
SwissQual
A Rohde & Schwarz Company

Standalone and system test solutions
QualiPoc Android - The premier handheld troubleshooter

- Multi-functional smartphone-based tool for voice and data service quality troubleshooting and RF optimization.
- Key Features
- **Intuitive User Interface**
  - The intuitive and customizable user interface is based on the latest features of today's smartphone technology and offers an easy operation;
- **Extensive set of service tests**
  - Including call tests, voice quality (including POLQA, PESQ, and SQuad08), data tests, video streaming including video quality (J.343.1) as well as app service tests;
- **High grade of customization**
  - Create your own monitor with the desired parameters based on templates;
- **Advanced RF optimization feature**
  - Advanced channel and cell locking are crucial for RF optimization feature to control the quality and coverage of a wireless networks.
- **OTA application update**
  - The over-the-air update function offers users a convenient way to keep QualiPoc application up to date.



Speech quality measurements in QualiPoc Android – The core of all MNT test systems



QualiPoc Android - Supported Test Cases (1)

Test cases
• Air Interface logging
• Forcing Functions (Technology/Band, preferred UARFCN, Channel, Cell)
• Voice Call testing (Call to any)
• Speech Testing (P.862 – PESQ, SQUAD or P.863 – POLQA NB and WB)   • M→Voice Server and M→M, MOC and MTC, DL and UL
• VoLTE Testing (P.863) including Enhanced Voice Services (EVS) Codec support *(depending on firmware)
• Speech Audio Delay (RTT) test
• Data (Ping, FTP DL/UL, HTTP DL/UL, Capacity DL/UL (multi thread HTTP/FTP), iPerf UDP/TCP
• HTTP Browsing
• Network Performance Test (iPerf & Capacity)
• Messaging (SMS, MMS, Email)

QualiPoc Android - Supported Test Cases (2)

Test cases
• YouTube Video Streaming incl. Video-MOS using ITU approved J.343.1 algorithm - completely developed by R&S

• Application service tests:
  • Dropbox (File up and download)
  • Facebook (Send post and picture, like post, delete post)
  • Ookla Speed Test (Latency, UL and DL throughput)
  • Line (Instant messaging)
  • Line (VoIP incl. audio MOS using POLQA)
  • Line (Video call including video quality using J.343.1)
  • WhatsApp (Instant messaging)
  • WhatsApp (VoIP incl. audio MOS using POLQA)
  • WhatsApp (Video call including video quality using J.343.1)
  • Netflix video streaming, KPIs: Time to 1st picture, Freezing, Resolution changes (bit rate)
  • FCC Speed app (UDP Latency and Packet Loss/Speed test (GET and POST HTTP)
  • Instagram (Send pictures and videos, post text and comments, KPIs)

• Generic Video Test
• Multi-RAB job (Simultaneous Voice and Data)
• Parallel job (Up to 3 jobs of any kind running in parallel)

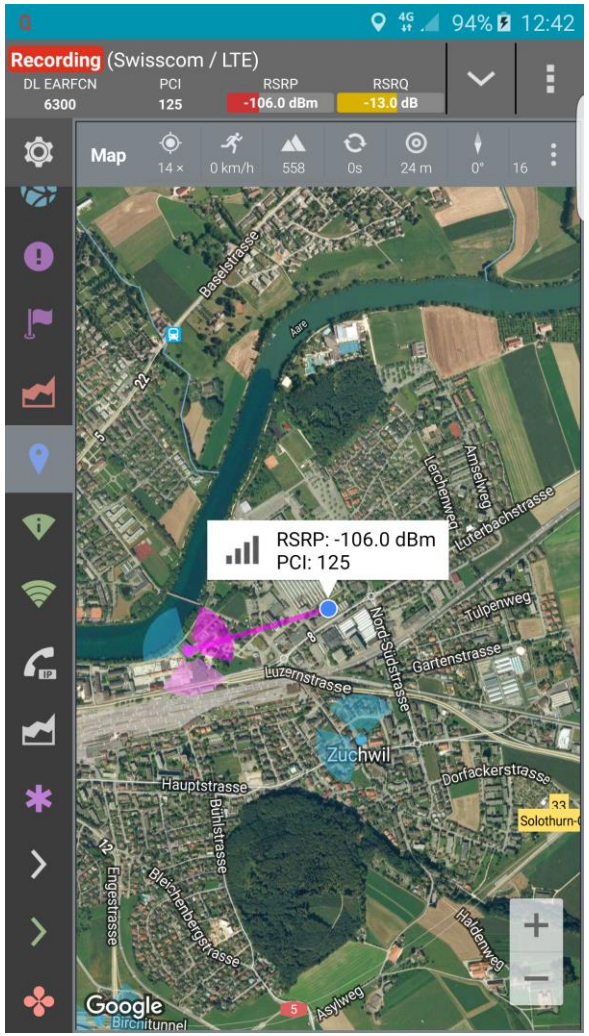
QualiPoc Android with latest Smartphones

- **Samsung**
  - Galaxy S9 — Cat18 (up to 1.2Gbps)
  - Galaxy S8/S8+ — Cat16 (up to 1Gbps)
  - Galaxy S7 / S7 Edge — Cat12 (up to 600Mb/s)
  - Galaxy Note 4 (SM-G910F) — Cat6
- **Sony**
  - Xperia XZ1 — Cat16 (up to 1Gbps)
  - Xperia XZ Premium — Cat16 (up to 1Gbps)
  - Xperia XZ / X Performance — Cat12 (up to 600Mb/s)
- **LG**
  - G5 — Cat12 (up to 600Mb/s)
  - G4 — Cat6
- **HTC**
  - 10 — Cat12 (up to 600Mb/s)
  - One (M9) — Cat6
- **Motorola**
  - Motorola Moto Z XT — Cat9

Also there are supported android tablets Samsung and Sony

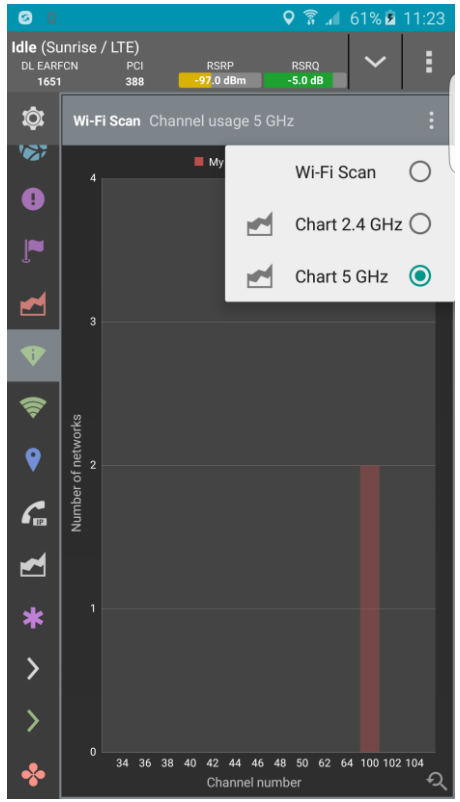
QualiPoc Android map monitor

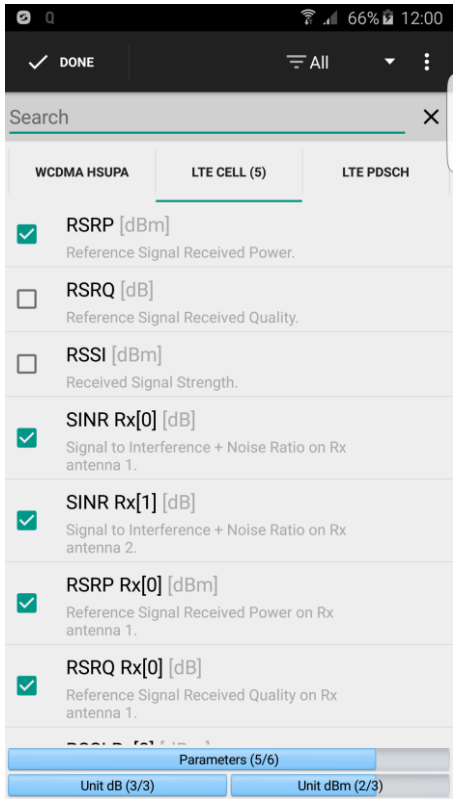
- **More detailed information on event and map monitor (indoor):**
  - Technology changes
  - Forcing actions
  - Waypoints
  - Screenshots taken
  - Text marker set/Photo marker taken
  - Test failures / Notifications.
- **QualiPoc supports multiple formats for indoor measurements**
- (pictures by built in camera, jpeg and png, iBawave project files, Google IndoorMaps).
- **Outdoor measurements**
  - GPS related information (Time, Latitude, Longitude, Speed and Accuracy)
  - Supported maps: Google Maps, Open Street Maps, Bing, HERE, etc.
  - Offline mode (caching)
  - BTS list support for all technologies
  - Serving BTS, Neighbor cells based on BTS cell list, Navigation to certain location, Load GPX tracks or predefined routes.



QualiPoc Android – additional features

- QualiPoc shows and logs Wi-Fi (2.4 and 5 GHz bands) related information of connected network:
  - SSID, BSSID, RSSI
  - IP address
  - Frequency
  - Channel number
  - Link speed
  - Connection status
  - Time stamp of last Wi-Fi scan result
  - Number of Access points found during scanning
  - Authentication time to Wi-Fi network
  - Access time to Wi-Fi network
  - Data Retention
- QualiPoc offers high grade of customization
  - Create own workspace and easy switching between them
  - Own monitor creation based on 3 templates and more than 200 parameters





Smart Benchmarker - System test solutions

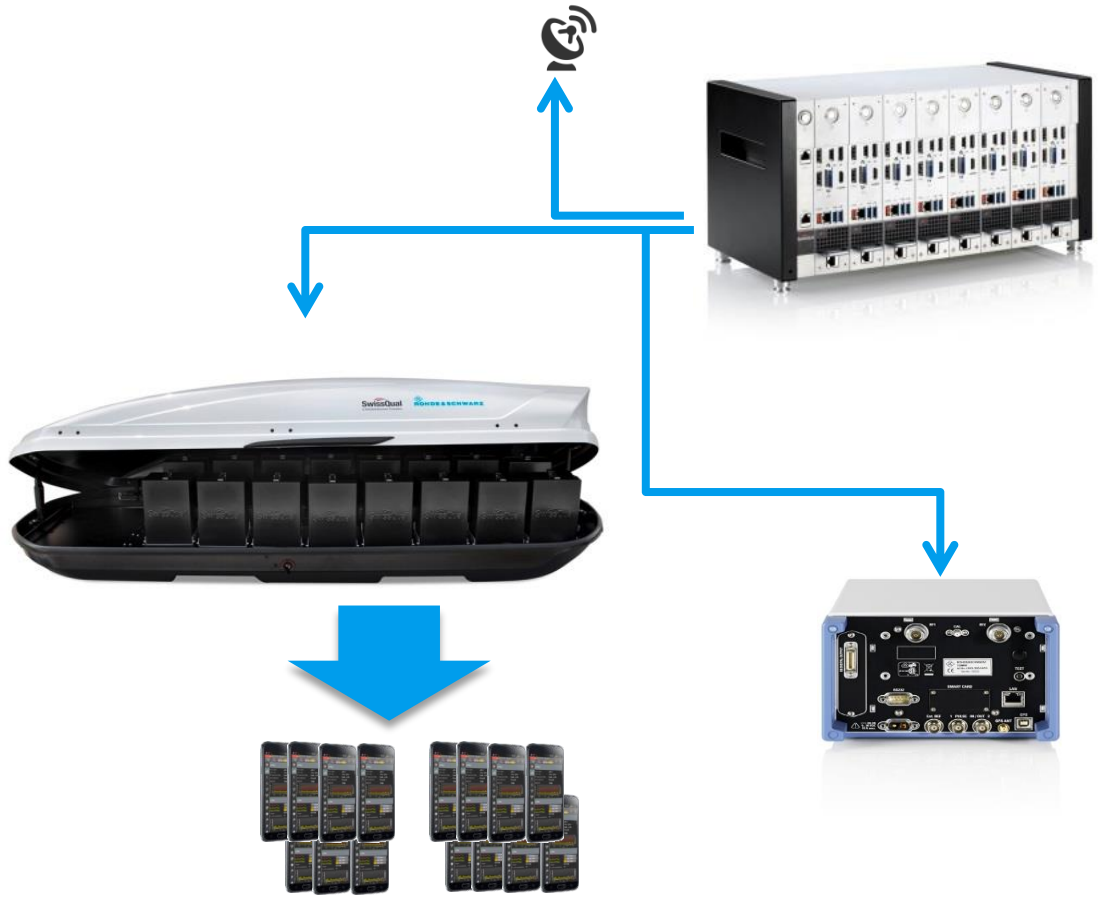
- Main objectives
  - Measure subscriber perceived **Quality of Experience**
  - Comparison against **competitor** to assess market situation
- Main Challenges
  - True subscribers' Quality of Experience assessment …still compliant with standards
    - **Voice**: POLQA – ITU-T P.683
    - **Video**: VMOS – ITU-T J.343.1
  - Reduce as much as possible Operational Expenditures
  - Minimize Re-drives
  - Reduce Configuration and User Errors

Save OPEX and CAPEX

Smart Benchmarker - System test solutions

Features and Highlights

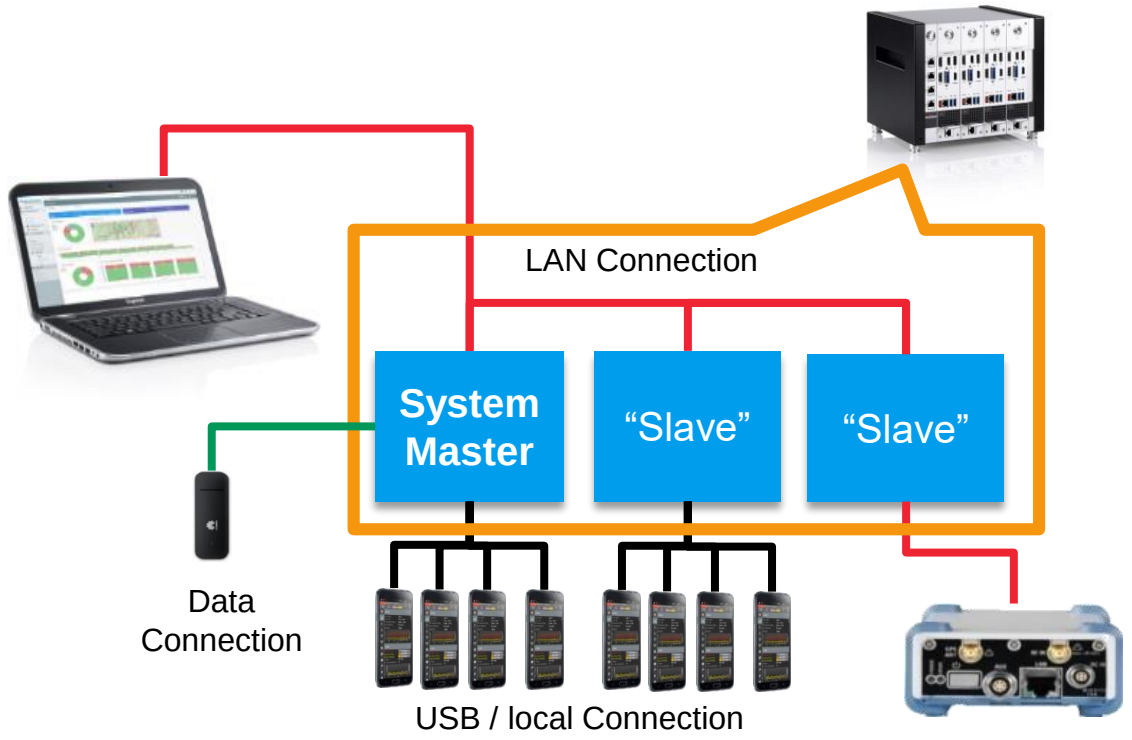
- Web-based
- Fleet management capabilities «native» in our platform
  - Alarming / Notifications
  - systems interconnection
  - Live Monitoring of units
  - Uniform Temperature and RF Conditions (TCM).
- Evolution of Diversity / NQView software
- Built on the same measurement engines
  - Maintain test structure and KPI's
- Installed on Benchmarker II / Benchmarker II Go - Chassis
  - CSM v2, CSM v1



Smart Benchmarker - System test solutions

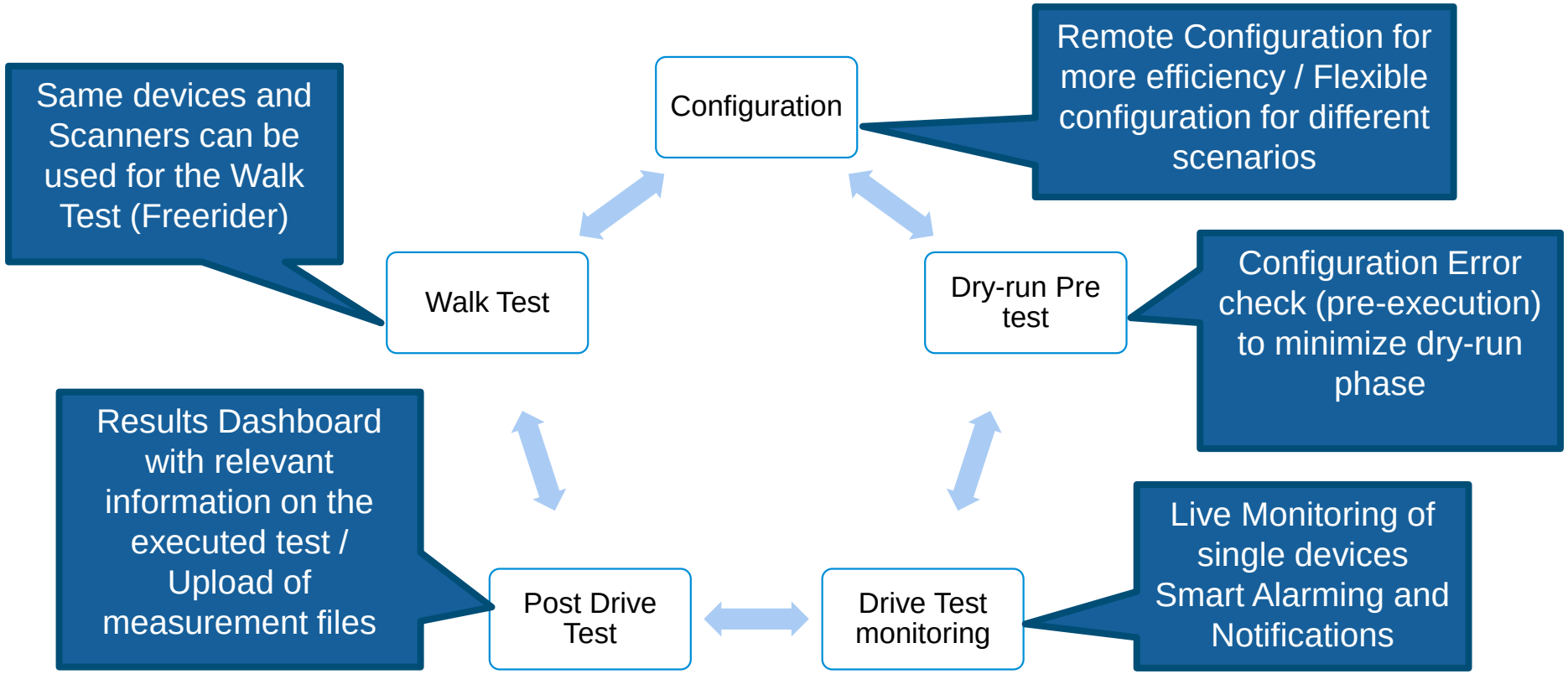
Architecture details - Local (in-vehicle) System

- SmartBenchmarker software runs on each CSM
  - One **“System Master”** CSM
  - Up to 7 (or 3) **“Slaves”** CSM
- Each of the CSM supports
  - Up to **4** Smartphones on PMW or,
  - Up to **4** TCM or,
  - Up to **2** ASM or,
  - **One** R&S Scanner
- Devices and scanner(s)
  - **Centrally** controlled / managed accessing the **master** via local web browser / laptop
- *Optional* **Data Connection** to allow Remote Access / Control



Smart Benchmarker - System test solutions

Benchmarking Test Phases - Where to save on OPEX and CAPEX



R&S Scanners
Standalone and system solutions / use cases

Network Planning and Optimization

- Model tuning
- Coverage validation
- System internal interference optimization (pilot pollution)
- System external interference detection
- Installation defect detection (crossed feeders, broken feeders)
- Uplink interference detection (Spectrum measurement)
- Decoding of BCH information (missing neighbors, configuration issues)

Benchmarking

- Coverage comparison per technology per operator
- RF quality comparison per technology per operator
- network non-intrusive: no SIM cards from MNO

Regulators

- Spectrum clearance-Complex multi-band multi-technology networks
- Network Survey with accurate verification of spectrum (BTS, coverage, channel utlization)
- Detection of illegal BTS, spectrum use, cross country RF spillover

TSME

TSMA

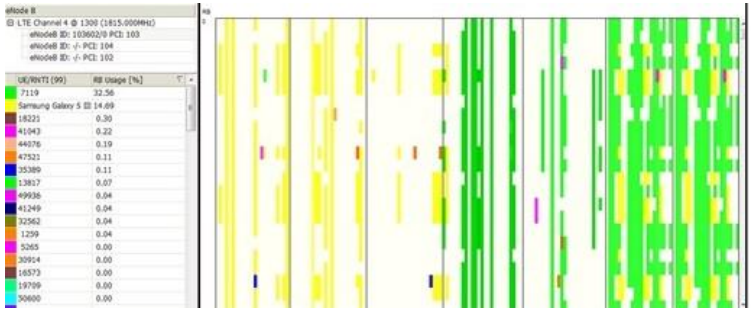
TSMW

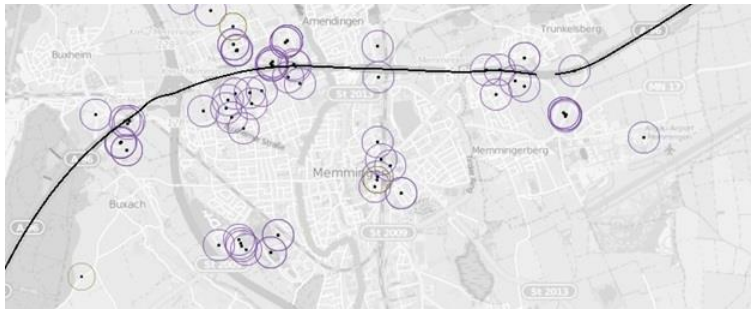
R&S Scanner unique benefits (1)

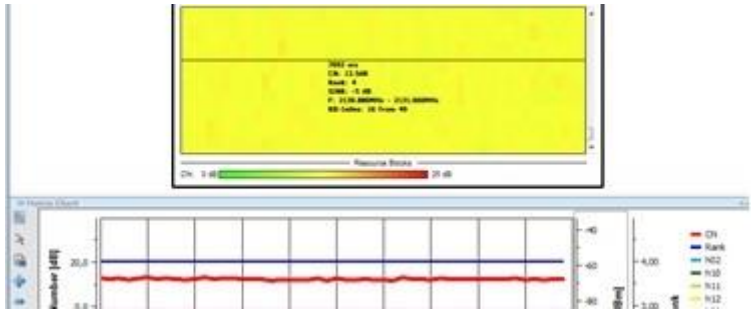
- Unbanded – **one instrument for all bands**
- **Simultaneous measurement** of LTE (FDD, TDD), WCDMA, GSM, CDMA, EV-DO, WiMax, TETRA, TD-SCDMA, eMBMS, NB-IoT / Cat NB1 and spectrum in all bands
- SW upgradable – adding new technologies in the field (e.g. NB-IoT)
- Market leading **sensitivity and dynamic range** with practically **no ghost codes**
- Intelligent scheduling: **all technologies measured in parallel at high speeds**
- **Highest measurement rates**
  - Even with BCH demodulation active
  - Even in dense networks (many Scrambling Codes or PCIs per channel)
- No GPS (holdover) required for CDMA/EV-DO measurements
- TSME and TSMA are upgradable to **4x4 MIMO**
- TSME and TSMA have **flexible band optioning** (changeable by customer)
- TSMW/TSME/TSMA measure correctly in **eMBMS enabled network**
- TSME platform already used for first **5G testing**
- Global service network with local presence

R&S Scanner unique benefits (2)

- Unique innovative features
  - **Smart Automatic Channel Detection** (ACD) for GSM, UMTS, LTE, CDMA/EV-DO, TETRA, Wi-Max.
    - Multi-band multi technology networks
    - tool setup time
    - re-drives
  - **LTE Downlink and Uplink Allocation Analyzer**
    - Non-intrusive analysis of resource allocations
      - Cell Load
      - Competition
      - How many users
      - Cell Efficiency
  - **Base station Position Estimation**
    - Source of interference across country borders
    - Competitor network density
    - Site sharing
  - **MIMO 4x4**
    - Scanner provides neutral assessment of the RF condition and achievable L1 throughput
    - Flexible solution: 4 TSMEs can be chained, or used separately!







NB-IoT scanning is supported

NB-IoT Secondary sync signals (NSSS)

NB-IoT Reference signals (NRS)

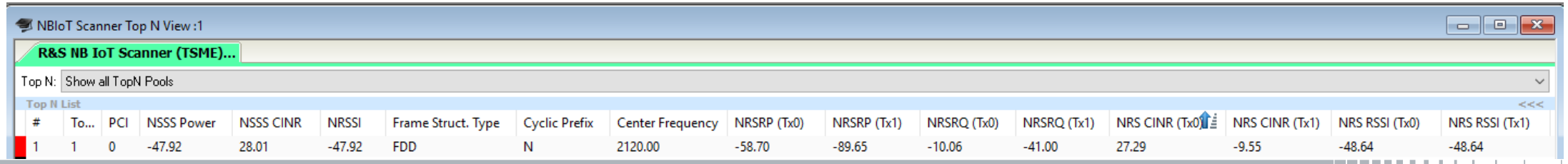
Parameter	[Unit]
1. TopN [1] TopX[1]	
1. TopN [1] TopN Decision NSSS Power[1]	dBm
1. TopN [1] TopN Decision NSSS CINR[1]	dB
1. TopN [1] TopN Decision NRSSI[1]	dBm
1. TopN [1] PCI[1]	
1. TopN [1] NRSSI[1]	dBm
1. TopN [1] NSSS CINR[1]	dB
1. TopN [1] NSSS Power[1]	dBm
1. TopN [1] Center Frequency[1]	MHz
1. TopN [1] NRSRP (Tx0) [1]	dBm
1. TopN [1] NRSRQ (Tx0) (1)[0]	dB
1. TopN [1] NRS CINR (Tx0) (1)[0]	dB
1. TopN [1] NRS RSSI (Tx0) (1)[0]	dBm
1. TopN [1] NRSRP (Tx1) [1]	dBm
1. TopN [1] NRSRQ (Tx1) (1)[0]	dB
1. TopN [1] NRS CINR (Tx1) (1)[0]	dB
1. TopN [1] NRS RSSI (Tx1) (1)[0]	dBm
1. TopN [1] Frame Struct. Type[1]	
1. TopN [1] Cyclic Prefix[1]	

01

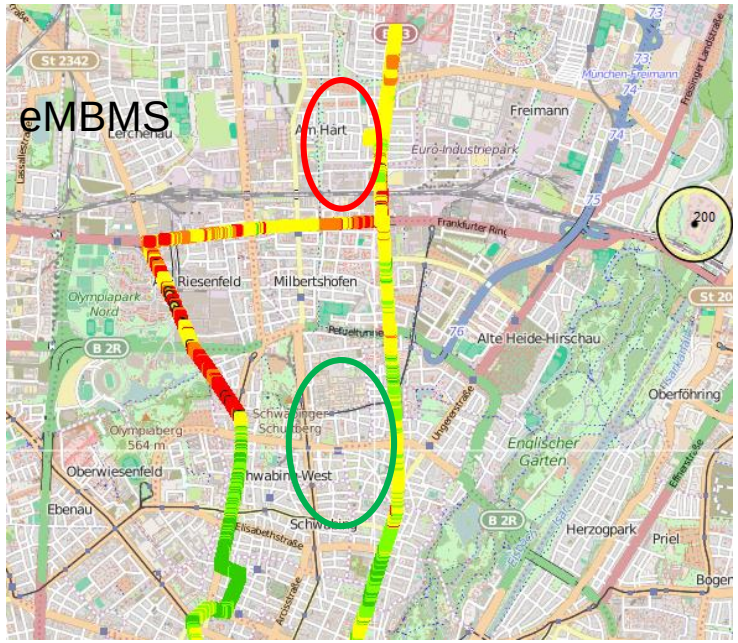
Non-intrusive analysis of NB-IoT. Measurements are based on synchronization and reference signals.

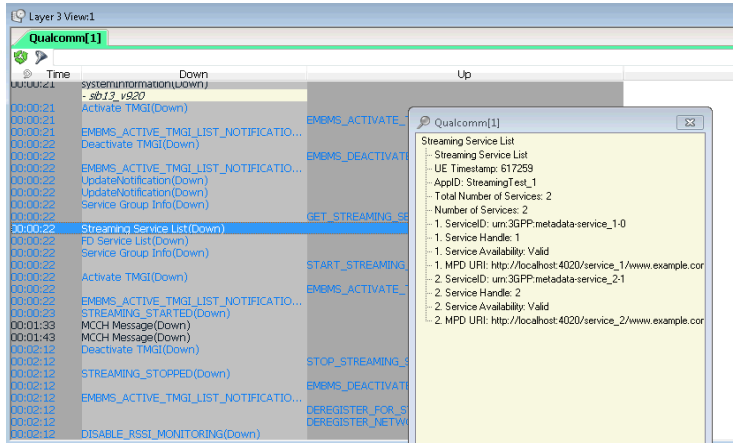
02

First Multi Technology NB-IoT scanner!



LTE eMBMS with scanner and testmobile





01

First scanner that measures correctly in eMBMS enabled networks today

02

Fast and accurate RF quality measurement of eMBMS network for optimization and troubleshooting

03

CIR analysis to check guard interval violations (ISI)

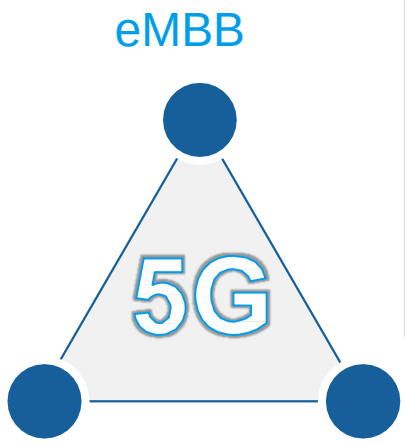
04

Testmobile: check the performance of the service by evaluating the mobile trace

The Triangle of 5G Use Cases
LTE-Advanced Pro (3GPP Rel.14) paves the way for 5G

mMTC / Massive IoT

- A diverse ecosystem (operators, manufacturers, local authorities, certification only for some technologies)
- Mix of technologies (GSM, Lora, Zigbee, WLAN, Bluetooth, Cat M, NB-IoT,…)
- It's all about cost efficiency and massive connectivity 1.000.000 devices/km2



enhanced Mobile BroadBand (eMBB) – the known playground

- Established ecosystem (operators, manufacturers, certification of devices)
- Evolution from existing technologies (LTE-A, 802.11 ad) and revolutionary additions (cm- / mm-wave)
- It's all about data (speed and capacity)

URLLC

- A significantly enhanced and diverse ecosystem (operators, manufacturers, verticals, certification not existing (yet))
- Existing technologies do not provide sufficient performance
- It's all about reliability and security (data and capacity)

5GTF scanner @ 28 GHz test setup

28 GHz omnidirectional Rx antenna R&S AC004R/L2

Signal generator as gNodeB (next generation Node B) with Tx horn antenna

R&S®TSME

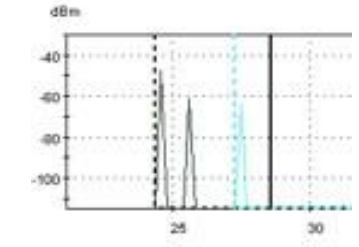
Downconverter

Local oscillator

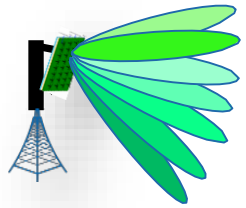
R&S®ROMES

5GTF measurements @28GHz in R&S ROMES

- Coverage measurements
- Power measurement on synchronization signal
- Total SYNC power
- Power per Resource Element (RE) (like Reference Signal Received Power – RSRP in LTE)
- Multipath/Signal Quality



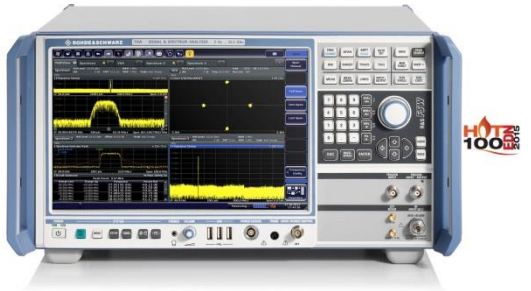
- Beamforming/ angle of arrival measurement



- Channel Impulse Response/Power
  Delay Profile per beam
  - See reflections
  - See which is the best beam
- RF Power scan
  - Total channel power
  - Uplink

Solutions from R&S – 5G NR testing

- Generate and analyze 5G NR wideband signals to characterize sophisticated RF components with:
  - R&S SMW200A vector signal generator
  - R&S FSW signal and spectrum analyzer
- Test your 5G NR sub-6 GHz and mmWave devices in production with:
  - R&S CMW100 communications manufacturing test set
  - R&S CMP200 radio communications tester
- Test 5G NR mmWave antennas over the air (OTA) with:
  - R&S ATS1000 antenna test system



Thank You!